THE

9480

ENGINEERING MAGAZINE

AN INDUSTRIAL REVIEW

VOLUME XXXIII

April to September, 1907

NEW YORK

THE ENGINEERING MAGAZINE

1907

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BY JOHN R. DUNLAP

THE ENGINEERING MAGAZINE

"THE WORLD IS ITS FIELD"

VOL. XXXIII. APRIL, 1907. No. 1.

NEW YORK AND PANAMA. A CONTRAST IN ENGINEERING ACHIEVEMENT.

By Ernest John Munby.

$600,000,000 is an underestimate of the engineering work under way in and tributary to New York City alone, exclusive of ordinary building and of Federal expenditures in the harbor. Every yard and pound and dollar of it is proceeding with civil engineers in charge and capable contractors doing the work. Construction three times as great as the equivalent of the Panama Canal is moving steadily and triumphantly to completion and success, and not a hint of inefficiency nor a breath of scandal about it all. If the Administration rejects the methods which the great railways and other constructive corporations have found universally best and most economical, it assumes a heavy responsibility. Here is a standard by which the comparative efficiency of Government engineering and labor and Departmental direction may be tested. The future holds the answer.—THE EDITORS.

AT a time when the construction of the Isthmian Canal is engaging so much public interest, the magnitude of the undertaking is apt to overshadow in the popular mind—Nationally, if not indeed locally—the importance of improvements in transportation facilities almost as great in conception and certainly more difficult in execution, which are now proceeding with very little in proportion of advance advertisement and ostentation.

That the dream of great minds, four centuries ago considered visionary but for the past hundred years the ambition of engineers, should be within definite prospect of realization as a National undertaking, is to Americans a source of justifiable patriotic pride and of international interest. The importance to the world's commerce of an interoceanic waterway by which sea traffic can pass between the two greatest oceans without a circuitous voyage around the Horn can hardly be exaggerated. Yet it is scarcely greater than the value, not merely to New York but to the United States at large (considering the prominence of the Metropolis as a seaport and commercial export

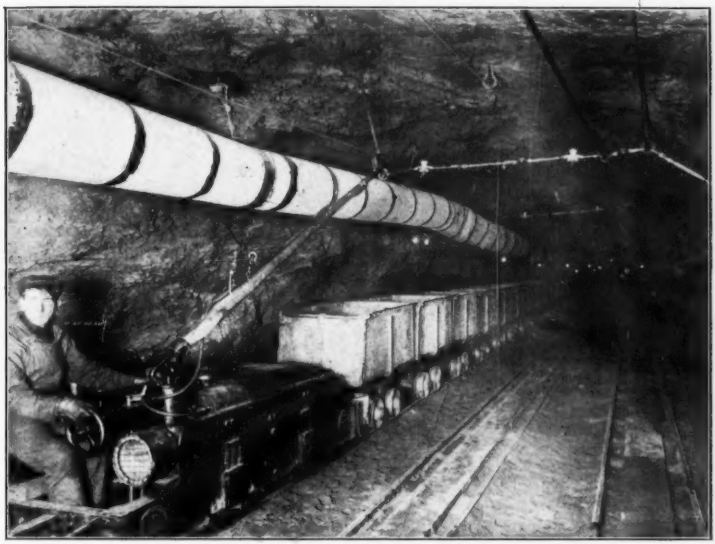
centre) of the provision of a number of continuous routes for railway and other vehicular traffic connecting Manhattan Island with the mainland by means of tunnels.

And yet it is very imperfectly realized that, with comparatively little notice from the public press though at a cost which in the aggregate will far exceed that of the Panama Canal, sixteen separate tunnels under the wide waterways surrounding Manhattan are in course of construction or actually completed, and will rapidly emancipate New York city from the limitations of its insular position. There are three systems, comprising eight tubes, under the East River; three systems, comprising six tubes, under the Hudson, and one system of two tubes under the Harlem River. And beyond all this, three more systems comprising six tubes between the Brooklyn Bridge and the Battery, two great Subway extension systems with a total of four tubes under the Harlem, and one system of two tubes north of the Williamsburg Bridge, are definitely projected and will be completed long before the Panama Canal, while certainly two more systems under the Hudson and probably others are proposed. The New York Central Railroad electrification and terminal work approximately equals the Hudson Company or Pennsylvania enterprises in total outlay, and the bridges add about $50,000,000 to the grand sum.

Residents of the neighbourhood of Thirty-fourth Street have their attention called to the work in progress by the concussions from subterranean blasting; passengers on ferryboats sometimes observe miniature geysers thrown up by escaping air from some submarine bore; sensational newspapers occasionally turn to the work as promising opportunity for a reportorial voyage of discovery and hairbreadth escapes, to be described in garbled language which uses "caisson," "lock" and "shield" as synonymous terms. But, though articles in technical journals have descibed with dignity and authority the details of individual sections of tunnel or the plant and equipment necessary for their construction, little has been said of the scope and importance in the aggregate of all the engineering work now in progress.

A comprehensive idea of its huge physical scope and economic significance is presented at a glance in the table on page 20.

The conditions under which the work must be conducted at Panama have been carefully and elaborately pre-ascertained and are *all*, with the possible exception of the necessary depth of some of the dam foundations, positively and exactly known; whereas the conditions to be encountered in much of the tunnel work are practically unascertainable. The test borings made along the line of route, both on land and under water, before the initiation of tunnel operations, reveal at



ELECTRIC LOCOMOTIVE WITH TRAIN OF CARS REMOVING SPOIL.
In the Hudson Companies' first tunnel, in rock near New York end. Air pipe leading to bulkhead is seen overhead.

the best with only approximate accuracy the nature of the ground to be encountered in the tunnel itself.

The nature of such excavation as is required for the Panama Canal —the operation of steam shovels and similar powerful machinery— may be observed at the site of the Pennsylvania Railroad's station at Thirty-third Street. But the removal of a similar quantity of material, especially when subaqueous or water-bearing, in the confined space of a tunnel will readily be understood to be infinitely more difficult. For example, in the cross-town tunnels of the Pennsylvania improvements some of the ground is handled by "steam" shovels which however are operated by compressed air, as the emission in any quantity of fumes possibly detrimental to workers is not permitted in underground work. Similarly the use of animal power for haulage is rarely possible, and, man power being impracticable on a large scale, mechanical and therefore electrical or compressed-air haulage apparatus is necessitated. Again, all underground work must be conducted by artificial light, and therefore (for the same avoidance of fumes) electric light; consequently electric wires and pipe lines have to be maintained under the worst possible conditions of moisture, corrosion by lime from "grout," and liability to breakage by blasting.

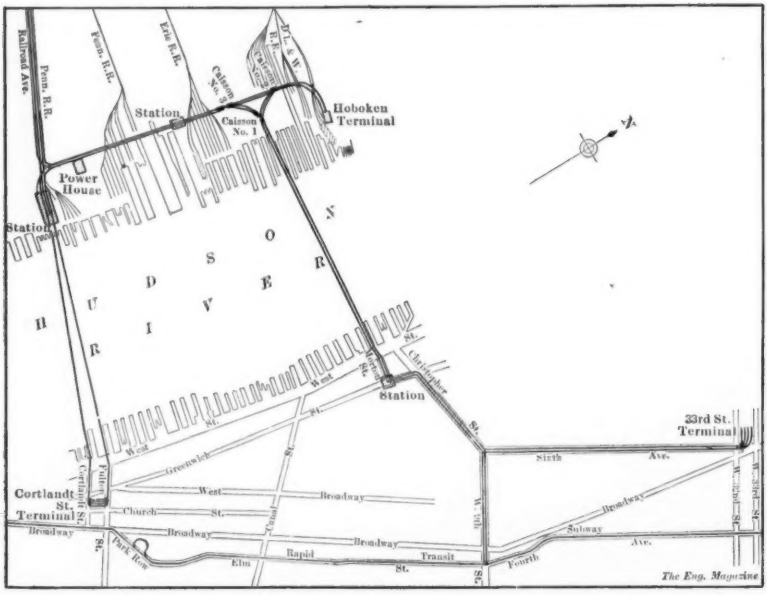
PART OF THE GREAT EXCAVATION FOR THE PENNSYLVANIA TERMINAL IN NEW YORK CITY.

It is approximately 400 by 1,600 feet in area, extending to the buildings seen in the far background and involving the removal of 2,000,000 cu. yds. of rock.

The unit costs of the various kinds of excavation at Panama have been carefully estimated and published by the Canal Commission, whereas unit costs are practically unobtainable from tunnel contractors, even where they are working on cost plus a fixed sum or cost plus commission basis, for the reason that the costs are governed so much by variable conditions as to vary not only between one tunnel and another but between different parts of the same tunnel.

As to labour conditions, there is no very great difference between the classes of labour employable at Panama and at New York, the principal consideration in both cases being the health of the employee; but whereas in the moist and malarial climate of the Isthmus the health of the population is fairly governable by proper medical and sanitary precautions, the tunnel companies have to contend with caisson disease, which after years of investigation is still almost an unknown quantity. It has been said that the men killed and wounded in tunnel operations are more in proportion to the number employed than the casualties of the Civil War, but this is probably an exaggeration; at all events, by the use of the medical lock for recompression of patients and the precaution of thorough pre-examination of compressed-air workers, most of the tunnel companies have so far reduced the number of cases of "bends" that the latter are exceeded by the number of accidents requiring surgical treatment, such as are bound to occur on any large contracting work.

To take in their chronological order the tunnels now completed or in course of construction, that which is now known as the "McAdoo tunnel" was the first transportation tunnel to be commenced, by some 30 years, and the first under the Hudson by several months to be completed. As originally projected in 1874 it was to have consisted of one large circular brick-lined tunnel, driven from a shaft at the foot of Fifteenth Street, Jersey City, to one at Morton Street, New York; this was abandoned. The present proprietors, the N. Y. & N. J. R. R., took up the work in 1902 and successfully drove the northern tube into the New York workings in March, 1905, completing its twin southern tube early in 1906, both under the direction of Mr. C. M. Jacobs, who had previously done successful pioneer work on the East River gas tunnel. To him, more than to any other one man, the success and the scope of present New York tunnel operations may be said to be due. Mr. Jacobs completed, where others for various reasons had failed, the first transportation tunnel under the Hudson, and is chief engineer of its extensive connections; he is in direct charge of a large part of the bigger Pennsylvania tunnels and on the consultative board to the whole system, and his work on

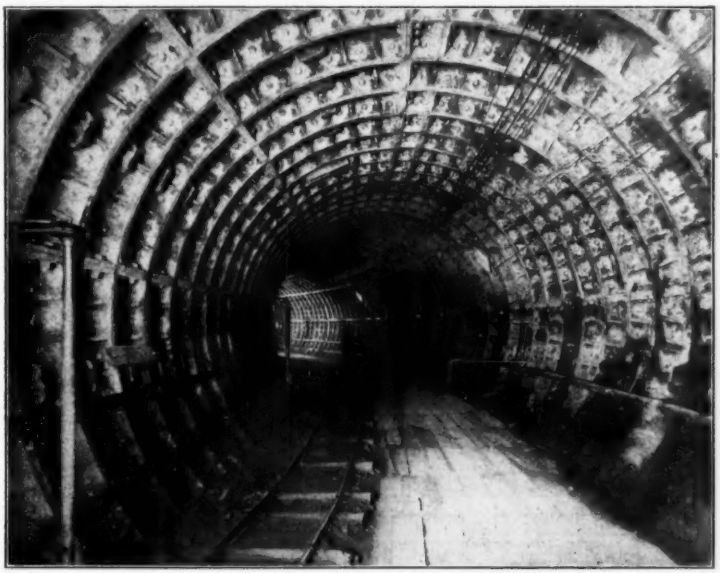


SKETCH MAP OF TUNNEL SYSTEM, THE HUDSON COMPANIES.
The map omits the northern part of the Railroad Avenue extension, north from the Penna. Station.

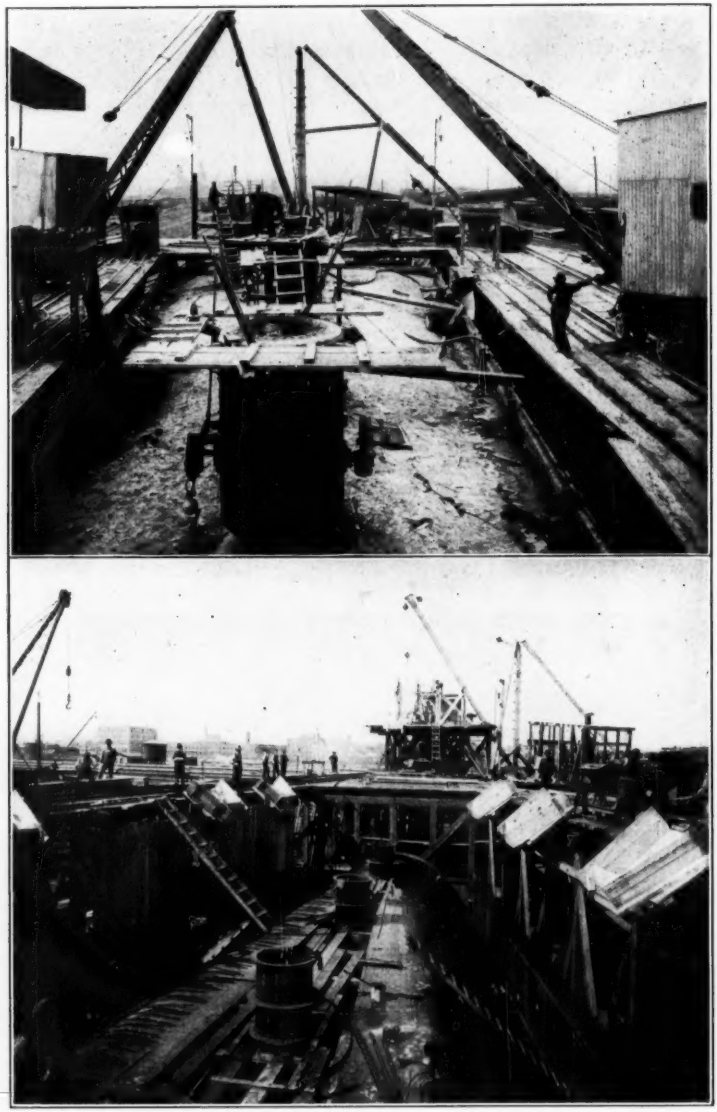
the East River gas tunnel has materially assisted both the survey and the forecasting of the ground to be encountered in the present East River railway tunnels.

The scope of the system including the original Hudson tunnel has been considerably enlarged by the alliance of the New York & New Jersey and the Hudson and Manhattan Railroads, and is now developed into an elaborate system best understood by reference to the accompanying map. The first two tunnels as completed are twin tubes 18 feet in external diameter and 5,650 feet long from shaft to shaft, and compose the northerly group shown on the diagram. From the New York end of these tubes, two tunnels are being driven through the city northward and eastward, via Brunswick and Christopher Streets to Sixth Avenue; there they fork, one branch turning east through Ninth Street to a junction with the Subway system at Astor Place, and the other running north under Sixth Avenue to a station adjoining the new Pennsylvania terminal at Thirty-third Street. This portion of the work, about two miles long, is not strictly tunnelling, being on the "cut and cover" principle. Meantime another pair of tubes, 16½ feet diameter and 5,970 feet long from shaft to shaft, are

being driven under the Hudson about a mile south of the first system. They are slightly divergent at the New York end, making a loop with a four-track station in the enormous Terminal buildings now being erected at Church and Cortlandt streets. Converging as they go westward under the river, these tunnels enter the Jersey City station, under the old Pennsylvania terminal there. From this point reach two main arms of the system. One goes west, following the lines of the Pennsylvania Railway and directly beneath them for 5,500 feet underground, emerging then upon an embankment level with the Pennsylvania tracks and continuing thus for about 4,000 feet more to a junction with these railway lines at Summit Avenue. The other arm, connected with this last described by a Y, turns north, parallel with the river front, passing beneath the Erie and Lackawanna terminals about 10,000 feet into its own "Hoboken Terminal." Directly beneath the Lackawanna yards this arm connects by a Y with the two original river-tunnel tubes first described; the crossings of east-bound and west-bound traffic imposed by this arrangement at the Y under the Lackawanna yards and that just west of the Pennsylvania station are effected in every case by carrying one tube over the other. The design of this work and the caisson arrangement and



CURVE AT MORTON AND GREENWICH STREETS, HUDSON COMPANIES' "WESTBOUND" TUNNEL.



TWO STAGES OF CAISSON CONSTRUCTION, IN THE HUDSON COMPANIES' WORK.

From these caissons (underground excavated chambers, watertight and under compressed air) the tunnel shields are driven. The lower view shows caisson No. 2 partly completed, with timber form and steel re-enforcement for the concrete roof. The upper shows caisson No. 1 completed, with the air locks in place.

construction by which it was achieved are among the most interesting and admirable features of the undertaking. The power house of the system is situated upon this section last described, between the Erie and Pennsylvania stations. The whole work is designed, of course, to provide liberal and elastic communication between the urban and suburban transit lines of New York and those of the New Jersey side.

It will then be seen that by the aid of the system above described, the Pennsylvania Railway, in addition to its own immense tunnel system, will have facilities for distributing its passengers without their leaving the cars, at points corresponding to its present three New York ferry terminals, and even more widely separated than they.

The cars of the McAdoo system also, joining the Pennsylvania tracks as above described at Summit Avenue, Jersey City, will have running powers over the Pennsylvania system as far as the latter is electrified, and *vice versa*. Pennsylvania passengers will therefore be able to proceed not only by through expresses from Washington and the South via the new line from Newark under Bergen Hill and the Hudson to Thirty-third Street, New York, and through to Long Island, but also by local trains may pass through the down-town tunnels to Church Street and through the "mid-town" tunnels to Morton Street, Christopher Street, Sixth Avenue and Astor Place.

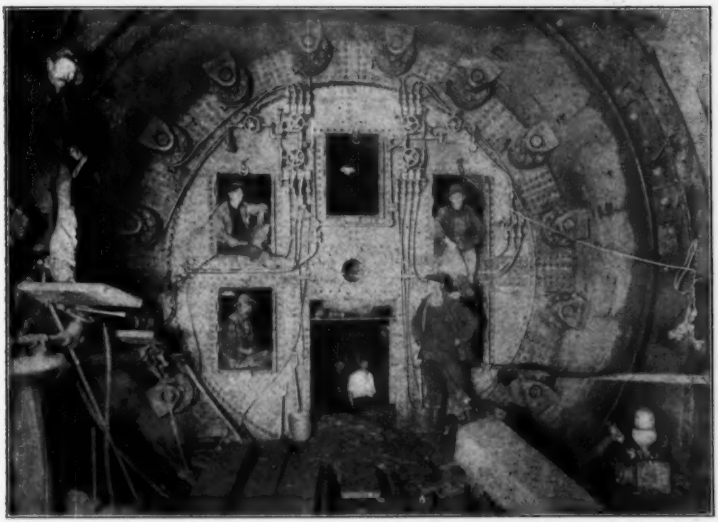
The second New York sub-aqueous transportation tunnel to be commenced, and the first by two years to be completed, was that under the Harlem River which is now in full operation—the only one of which the inside is as yet familiar to the travelling public. Whereas the width of the waterway traversed is less than one-tenth that of the Hudson and the difficulties encountered less in proportion, this tunnel is remarkable for the originality of the methods adopted and the complete success of the work, and deserves more extensive description but does not come within the scope of an article on progressing work.

The third system to be commenced and the fourth to be completed is the Battery tunnel by which the Rapid Transit Subway is extended to Brooklyn. This system comprises two tubes each about 6,500 feet long, of which 4,150 feet is under open water, with 500 feet of approach tunnel from the present subway line at the Battery and an open-cut approach leading to the surface at the Brooklyn end. Work was commenced at the New York shaft in March, 1903, and at a corresponding shaft in Brooklyn, from which points each tube was driven from both ends; the two opposite headings of the northern tube met on December 14 last and an opening has just been made (March 1) between those of the southern tube. After the actual driving of the tunnels was commenced the average daily advance for

THE INTERIOR OF A CAISSON. CUTTING OUT THE CONCRETE "PLUG" THROUGH WHICH THE SHIELD IS TO PASS.

This is the Hudson Companies' caisson No. 1. At the bottom on both sides are seen the concrete steps for the ways on which the shield slides.

all four headings, including all delays, was 10 feet; the best daily record was 14 feet with the shield in coarse sand. These tunnels involve a total excavation of about 120,000 cubic yards of material of which only about 55 per cent is sand and other soft ground, the two tunnels being clear of rock for only 3,500 feet of their total length. The completed cost of the tunnel will be approximately $4,000,000, and of the entire extension about twice that sum. The tunnels will provide through connection between the whole of the present New York Rapid Transit Subway system, including its authorised extensions, and the system of the Brooklyn Rapid Transit Railways, and of several plans now projected it should be the most potent factor in relieving the present congestion of traffic on the bridges.

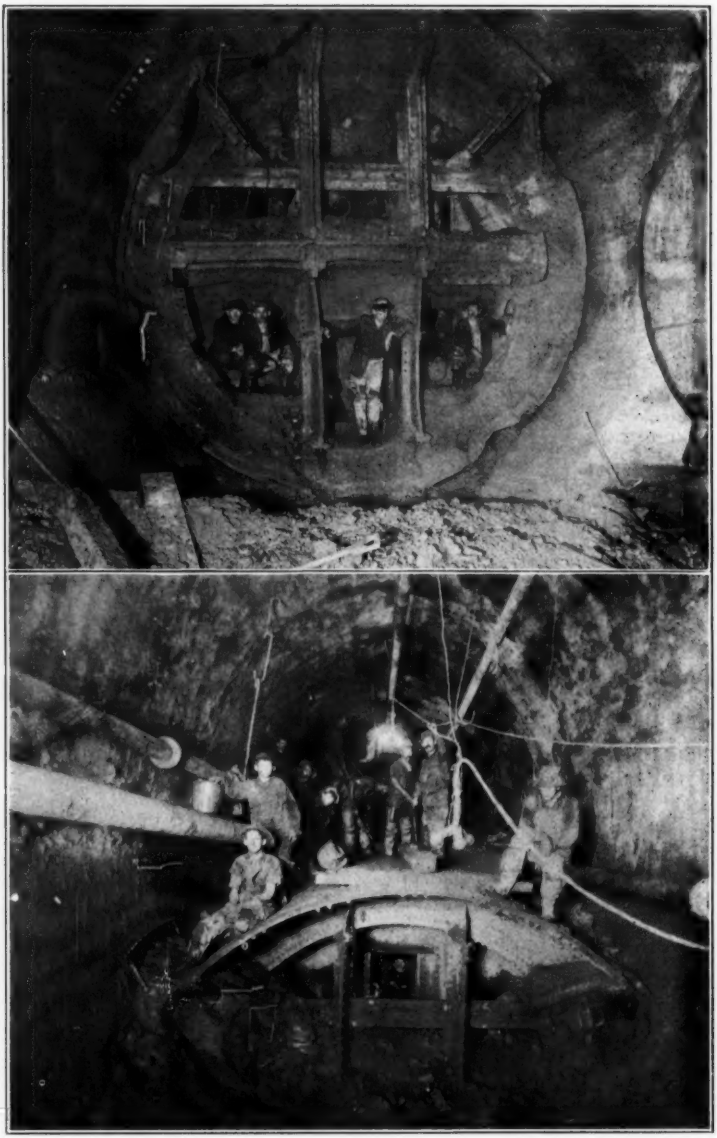


REAR VIEW OF A SHIELD, SHOWING THE "TAIL" IN WHICH THE IRON TUNNEL LINING IS ERECTED.

Around the edge are the jacks by which the shield is shoved, with hydraulic pipes supplying them. The spoil is thrown back through the small doors.

The fourth pair of tunnels to be commenced and the third to establish connections under water were the Hudson tunnels of the Pennsylvania system, and for greater convenience in making clear the advantage of this system in increasing transportation facilities it may be as well to describe the different portions of the work *seriatim* from the present Pennsylvania system instead of in the order of their completion.

Two tracks will branch from the present line at Newark through Harrison, where a large yard, with round house, passenger station,



TWO VIEWS OF THE FRONT OF A SHIELD AS IT ADVANCES.

No. 3 shield of the Hudson Companies. Above, it is shown entering caisson No. 2; the cutting edge is damaged in service by blasting or by the powerful shoving of the jacks against obstructions. Below, it is moving through the old brickwork of the original tunnel entrance.

and 1,200-foot platforms, will be located. At this point electric locomotives taking power from a third-rail system will be substituted for the steam locomotives. From Harrison the new line follows the old Pennsylvania tracks for a mile, when it diverges to make a bee-line for the western portal of the Hudson tunnels where they enter Bergen Hill at Homestead, New Jersey. The tracks are carried on an embankment averaging 18 feet in height above the Hackensack "meadows," requiring 4,000,000 cubic yards of filling, most of which comes from the New York tunnels. The site of the Harrison yards has already been raised considerably and several acres of made ground completed along the Passaic shore; the dump for rock excavated from the tunnel under Bergen Hill also constitutes what will be the railroad embankment westward from that point.

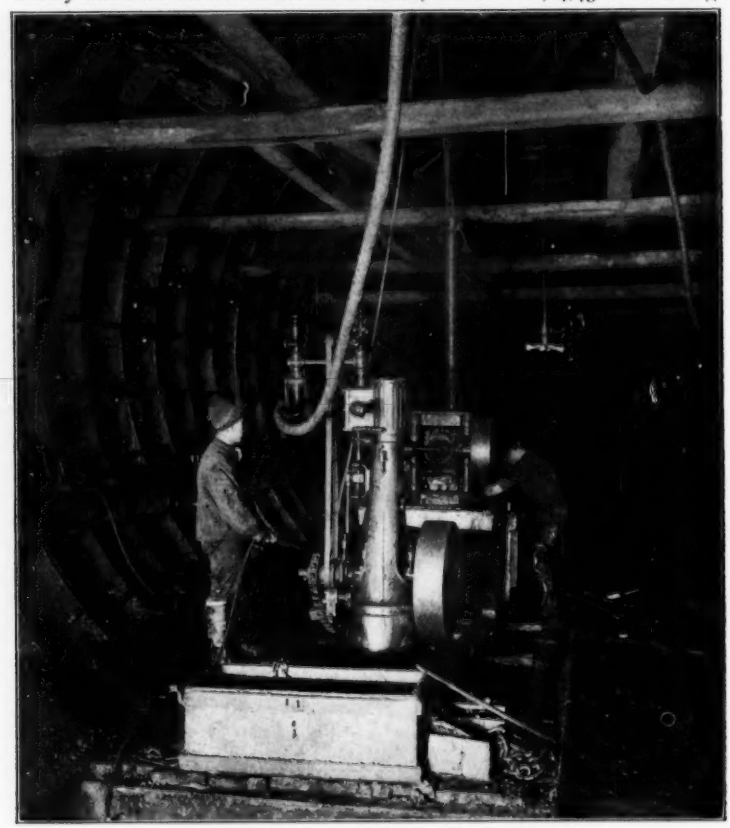
ERECTING THE IRON RINGS LINING THE PENNSYLVANIA TUNNEL.
The erector from the shield is mounted on timbers.

Large bridges are required where the new track crosses the Hackensack River and the present Pennsylvania and D., L. & W. tracks, the former being a drawbridge and the latter a series of spans aggregating 1,200 feet and somewhat complicated by the angle at which the tracks cross. The drawbridge will have masonry piers and abutments and the others concrete, the largest of the latter being 600 feet long, 20 feet wide, and 38 feet high, of which 20 feet is underground;

this work is now well advanced. These substructures are being built without any interruption of the traffic on either line which averages 20 trains an hour.

The Bergen Hill tunnels, of which there are two, each containing one track, will be 6,000 feet long from the Homestead portal to the Weehawken shaft. They are of horseshoe section, about 20 feet high and wide. Work on these is rapidly progressing, over 1,000 men being employed.

The Hudson River tunnels, of which there are two, each to carry one track, are 6,590 feet long from the Weehawken shaft to that at Thirty-third Street and Twelfth Avenue, New York, 4,430 feet being



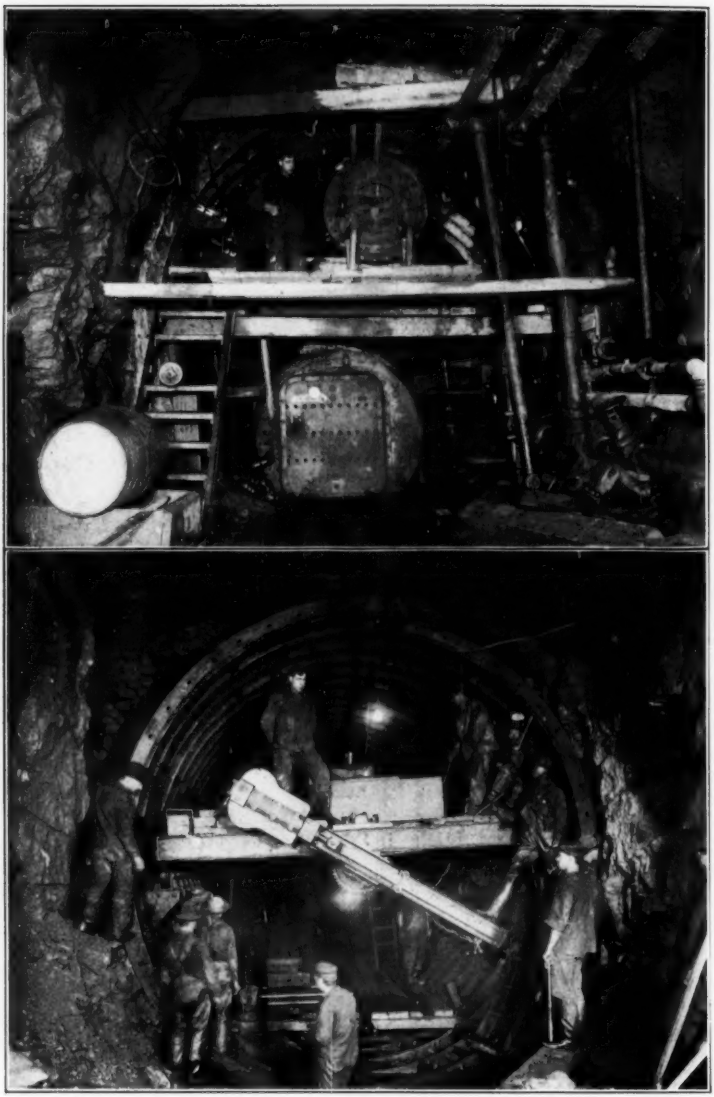
INSIDE ONE OF THE PENNSYLVANIA TUNNELS.
Making exploratory boring with the "Calyx" machine, for the screw-piles which are to aid in supporting the tubes.

under open water. These are 23 feet in diameter, lined with cast-iron segments, which will in turn be lined with concrete of a maximum thickness of 30 inches. Work on the shafts was commenced in June, 1903, and a heading started on the line of the tunnels in rock in October, 1904, from the New York end, and in the following January from Weehawken. When the shields emerged into the river silt very rapid advance was made, the two shields meeting under the river on September 12, 1906, in the northern tunnel, and not quite a month later in the southern. On account of the extreme fluidity of the material through which a large part of the tunnel passes, it is thought that when the removal of the air pressure decreases the buoyancy of the tube the added weight of the concrete and the live load of passing trains may cause it to settle, and as a precautionary measure against this steel screw-piles 2½ feet in diameter are to be sunk to bed-rock at intervals of 15 feet to support the iron. Some of these will have to be sunk to a depth more than 150 feet below the tunnel. The O'Rourke Engineering Construction Co. are the contractors for this portion of the work.

The next section from the Twelfth Avenue shaft to the Thirty-third Street station comprises two single-track tunnels almost entirely in solid rock for a distance of 2,700 feet. The terminal station site extends from Ninth Avenue to Seventh Avenue and from Thirty-first to Thirty-third Street, covering approximately 1,600 by 400 feet, and involves 2,000,000 cubic yards of excavation of which between 80 per cent and 90 per cent is complete.

The next 100 feet east from Seventh Avenue is being done by Messrs. Westinghouse, Church, Kerr & Co. to facilitate their arrangement of the electrical plant for which they are also the contractors; the remaining 5,500 feet of the cross-town tunnels is in the hands of the New York Engineering & Contracting Co. The latter part (eastward from the station) consists of two larger tunnels approximately rectangular in section as excavated, each to accommodate two tracks and to be lined with concrete so as to form two tubes symmetrical with those under the river, with which they connect in shafts at First Avenue. From thence, four parallel tubes will extend to a shaft at Front Street, Long Island City. These are also being driven by shields advancing from both ends, about 1,000 feet of the three southernmost tubes being constructed from the Manhattan end and nearly 300 of the northern, the Long Island headings to meet them having advanced some 300 feet.

This East River work on this system is being done by Messrs. S. Pearson & Son, Inc., who are also contractors for the next section,



IN THE BATTERY TUNNEL OF THE SUBWAY EXTENSION.

The upper view shows the air locks at the entrance to the section under compressed air. The lower shows the erection of the iron lining, by an erector carried on the finished portion of the lining.

from Front Street, Long Island, 2,000 feet east to East Avenue, comprising four tunnels joining those under the river; part of this work is in solid rock and part in mixed ground, some of the latter requiring heavy and elaborate crown-bar timbering, part having been done under air pressure and part atmospheric.

For the next ¼ mile eastward the contract has not yet been let; it is in ordinary Long Island soil with rock bottom, and will probably be excavated on the "cut and cover" principle.

Work on the Sunny Side yards at the Long Island end of the tunnel system is in progress and will require some 2,300,000 cubic yards of excavation, mostly gravel and sand, and some 2,000,000 yards of filling.

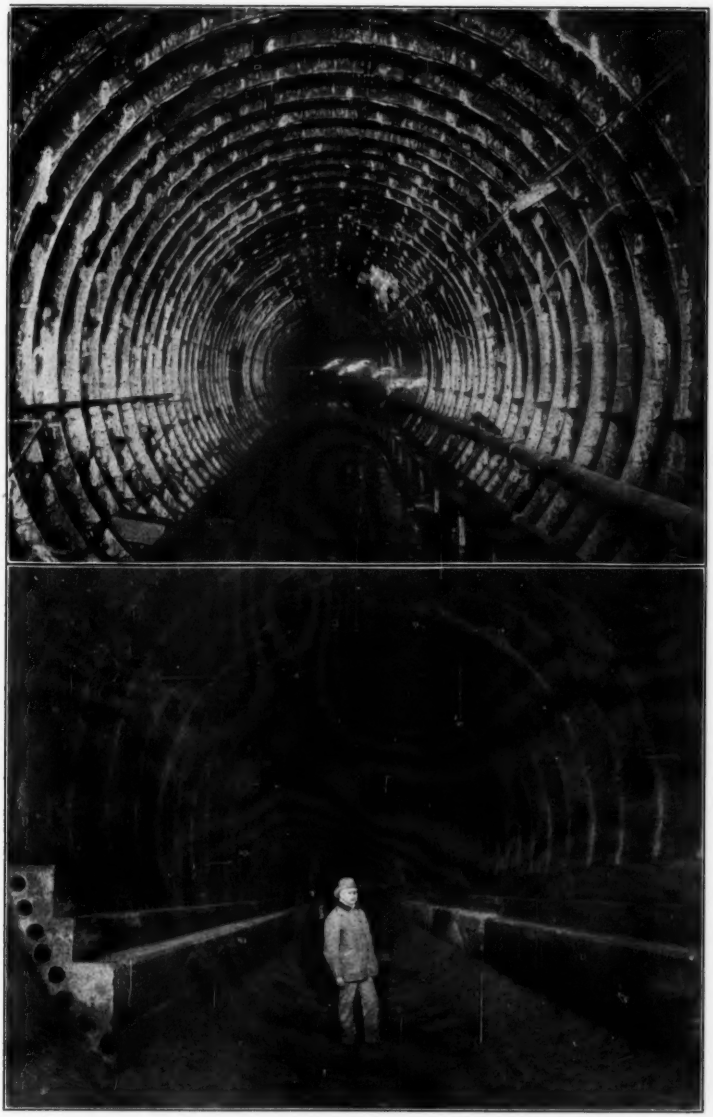
The advantages of this system, by which passengers from, say, Philadelphia can reach Brooklyn or any point on Long Island without two changes from train to ferry, or *vice versa*, and a drive across New York as at present, are readily appreciable. It is proposed to run trains from Thirty-third Street, New York, to Harrison, New Jersey, at an average schedule rate of 60 miles an hour. As there are no grade crossings and few curves or signal points in that distance it ought to be readily achievable. The advantages to suburban residents on Long Island will be no less, and when the Pennsylvania's dream of a great deep-water harbor for Atlantic liners at the extreme end of Long Island is realized, European mails, passengers, and freight will reach New York 4 or 5 hours earlier than at present, avoiding all delays of fog and traffic in the Narrows.

The New York & Long Island Railway is the next system to afford through communication, more especially between the surface-car lines of New York and Brooklyn. This system is composed of two tubes each 4,300 feet long under the East River at Forty-second Street, with approaches leading from the present Grand Central Station and out to the surface at Long Island City, the latter involving some 1,500 feet of open cut. Advantage was taken of Man of War reef in the middle of the river just below Blackwell's Island to accelerate the driving of these tunnels. A caisson was sunk within a cofferdam down upon and into the reef, from a shaft below which headings were advanced to meet those coming from the New York and Long Island shores, the excavation being thus attacked in four places instead of two. An extensive power plant and offices are now erected on an artificial island where formerly only a few feet of rocks was visible at low tide. Nearly three-quarters of these tunnels is constructed in rock, the remainder being mixed ground similar to that encountered in the P. R. R. East River tunnels.

Another undertaking of the first magnitude which is under full headway toward completion within and adjoining New York is the electrification of the New York Central Railroad and the new terminal construction connected with it. Briefly, this involves the excavation of a two-level terminal to accommodate 25 miles of tracks, the express level being 15 feet below the street and the suburban 25 feet lower yet, the present grade of the tracks being regained in about three-quarters of a mile. The total yardage to be removed for this work alone is estimated at 3,000,000 cubic yards, almost all rock. Electric operation will extend for 24 miles on the Harlem and 34 miles on the Hudson division, about 16 miles altogether (roughly) being now electrified. The two power houses, at Yonkers and Port Morris, will supply 40,000 kilowatts at 1,100 volts. The work was commenced in August, 1903, and will be completed in 1910. It must, of course, be carried out without suspending the operation of the enormous traffic of these roads.

Just crossing the threshold between preparation and construction by contract are the new Subway extensions known popularly as the "East Side" and "West Side." The former will run from the Battery to One Hundred and Sixty-fourth Street, by way of Church, Vesey, Broadway, Fifth Avenue, Thirty-fifth and Thirty-sixth, Lexington, and Park Avenues, with tunnel crossing under the Harlem River. It will have a total length of 12 1/5 miles of four-track subway, two-deck on Lexington Avenue and two-compartment elsewhere. The excavation will be all in rock above Fourteenth Street, and with the pipe galleries included may be expected to cost nearly $40,000,000. The "West Side" line runs from the Battery to a terminal near Woodlawn Cemetery, by way of Greenwich, Morris, West Broadway, Washington Square, Greenwich Avenue, Seventh Avenue to Fortieth Street, Central Park West and Eighth Avenue, McComb's Lane, One Hundred and Sixty-second Street, and Jerome Avenue. Like the other, it tunnels beneath the Harlem River. The total length will be 14 miles of four-track subway, with about five miles more of two-track subway extension on Jerome Avenue, and the expense of the work may be expected to reach $42,000,000 with a possible addition of $8,000,000 for pipe galleries. The "Bridge Loop," involving 7,000 feet of four-track subway in Manhattan alone, involves $5,000,000 for the work now advertised and $15,000,000 when the Brooklyn portion is included.

Into any conspectus of large engineering work in progress in Manhattan must enter also the East River bridges and some smaller structures over the Harlem and in the boroughs of Queens and the



THE BATTERY TUNNEL OF THE SUBWAY EXTENSION.

With the iron lining ready for the concrete, and with the concreting finished, ready for track laying.

Bronx. The Williamsburg Bridge, nearly complete, is to be altered on the Manhattan end to allow subway trains to run over the structure into Brooklyn. The cost of the original structure was about $12,000,000. The Blackwell's Island bridge, costing $15,000,000, is well advanced, the masonry being finished; and of the $20,000,000 Manhattan bridge the tower foundations are complete. The Pelham Bay, University Heights, and Borden Avenue bridges add another million to the total.

And beyond all this is the huge work for new water-supply, with present annual expenditures of $3,000,000 on contracts for possibly $40,000,000, and a total outlay of $162,000,000 in view. A *résumé* of the entire programme is given below:—

Work.	Principal Contractors.	Cost or Estimate.
Pennsylvania Tunnels and Terminals.	Wm. Bradley. O'Rourke Eng. Constr. Co. N. Y. Eng'g & Contracting Co. S. Pearson & Sons. Westinghouse, Church, Kerr.	$100,000,000
Hudson Company's Tunnels, Subways and Terminal.	Hudson Cos. Degnon Contracting Co. O'Rourke Eng. Constr. Co.	100,000,000
New York Central Terminals and Electrification.	O'Rourke Eng. Constr. Co. General Electric Co. General Railway Signal Co.	80,000,000
Battery Tunnels and Subway Extension.	Degnon Contracting Co. N. Y. Tunnel Co. Cranford & McNamee.	9,000,000
N. Y. & L. I. Tunnels.	Degnon Contracting Co.	4,000,000
Subway Extension and Pipe Galleries. East Side.	Not yet let.	40,000,000
Subway Extension and Pipe Galleries. West Side.	Not yet let.	50,000,000
Subway Bridge Loop.	Not yet let.	15,000,000
Manhattan Bridge.	Ryan-Parker Construction Co.	20,000,000
Williamsburg Bridge.	N. J. Steel & Iron Co.	15,000,000
Blackwell's Island Bridge.	Penna. Steel Co.	15,000,000
Smaller Bridges.	Snare & Triest, Lawler Bros., Degnon Contracting Co., Godwin Construction Co.	1,000,000
	Total	$449,000,000
New Water Supply.		162,000,000
	Grand Total	$611,000,000
	Estimated Cost of Panama Canal	$190,000,000

The fact that all this extensive and important work is going on untainted by any breath of scandal in direction or execution, unheralded by any Presidential messages to Congress, little discussed by even the local press and almost unadvertised by its promoters, is striking by comparison with the amount of attention given to the National construction of an Isthmian Canal. The quiet and efficient completion of all these great improvements by public contract is an interesting commentary on the controversy aroused by the action of the Government with reference to Panama contractors.

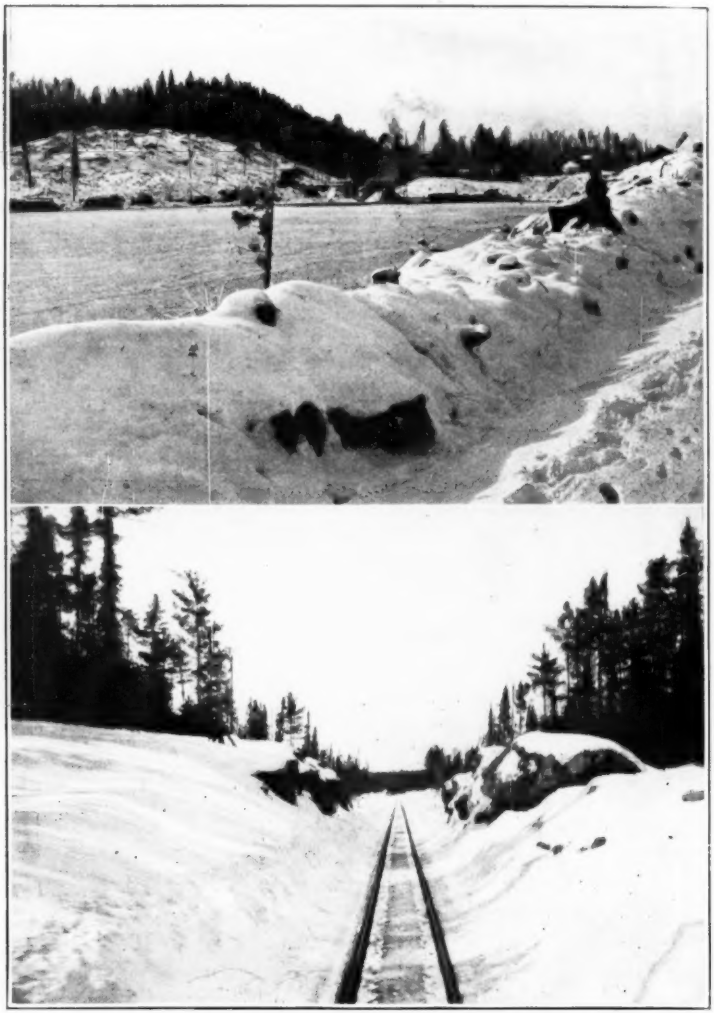
TEMAGAMI STATION. A DAILY SIGHT IN SUMMER.

COBALT, CANADA, THE NEW SILVER-MINING DISTRICT.

By J. E. Hardman.

The remarkable richness and complexity of its deposits, and the absolutely unique character of its geological structure have given to mining in the Cobalt district an unparalleled interest and uncertainty, an interest which in less than three years has gained for it a world-wide reputation, and an uncertainty which the accumulated experience of its history has not been able to remove. Mr. Hardman's article, based upon an extensive personal acquaintance with the district, presents a review of the conclusions which may be drawn from present conditions.—THE EDITORS.

THE preamble to the Act authorizing the construction of the Temiskaming & Northern Ontario Railway, among other paragraphs contained the following clause: "Whereas exploration of the Province (Ontario) has shown that, in that district of Ontario which lies between Lakes Nipissing and Abitibi and northwesterly from Lake Temiskaming, there are . . . . deposits of ores and minerals which are expected upon development to add greatly to the wealth of the Province . . . . ," the clause having been framed without any knowledge (on the part of the Legislature)



ON THE LINE OF THE T. & N. O. RAILWAY.

The upper picture shows the McKinley-Darragh mine, from the track.

of the significance of its language, or of the vast amount of mineral wealth which this railway would open up. Nor had the first discoverers of silver, Messrs. McKinley and Darragh, when in July, 1903, they stumbled on the outcrop of a rich vein on the southern shore of Long Lake (now known as Cobalt Lake) any conception of the value of their discovery, or of the tremendous influence which that discovery would exert upon the financial barons of Wall Street and other big money centres.

THE MCKINLEY-DARRAGH—THE ORIGINAL DISCOVERY OF COBALT CAMP.

The district is decidedly unique, and has earned the adjective "freak" which was bestowed upon it last summer by the eminent engineer, Mr. John Hays Hammond. It is a freak because it does not conform to the experience experts have had in other silver-bearing districts, and because its eccentricities are not yet understood, and by reason of its petrology, which is unique.

The district of Cobalt in its larger sense embraces portions of the townships of Coleman, Lorrain, Bucke and, in all probability, portions also of the townships of Firstbrook and Dymond. In its narrower sense it is confined to an area of six or seven square miles in the eastern half of the township of Coleman. It derives its name from the prevalence of the metal cobalt in the distinctive mineral of the region, which is smaltite, an arsenide of cobalt. By rail the town of

TWO VIEWS IN COBALT—BELOW, A TYPICAL STREET CROWD; ABOVE, THE NORTH END OF THE TOWN.

Cobalt lies 103 miles north-northwesterly from North Bay, a station on the main line of the Canadian Pacific Railway at the head of Lake Nipissing. Cobalt is 330 miles nearly due north of the city of Toronto, which is the chief supply centre for this new region.

Tales concerning the first discovery are somewhat numerous, but there are two well authenticated stories which, briefly, are as follows:— Messrs. McKinley and Darragh, both experienced lumbermen, having a contract for the supply of ties for the Temiskaming & Northern Ontario Railway, had frequent occasion to pass from the line of the right of way to their tie camps by way of the southern end of what is now called Cobalt Lake. On one of these occasions the outcrop of a vein which carried heavy mineral was noticed, and some of that mineral was taken in to the railway camp and was, at first, somewhat naturally taken for copper ore as it was niccolite, which carried the usual bright red bronze colour. The then chief engineer of the railway, Mr. W. B. Russell, later took a piece of the ore to Toronto for examination and analysis. Other pieces were also shown to Mr. Thomas W. Gibson, then Director of the Bureau of Mines, now Deputy Minister of Mines, who at once recognized its unusual character, and on his return to his office at the end of October 1903 instructed the Provincial Mineralogist, Mr. W. G. Miller, to visit the locality at once and make as thorough an examination as possible.

THE NOVA SCOTIA MINE.

Nearly contemporaneous with this discovery by McKinley and Darragh came the accidental discovery of metallic silver by a blacksmith named LaRose, who was in the employ of the contractor for the building of the railway. His story is that, being at his forge one day near the northern end of Cobalt Lake, he saw a red fox near by in the bush and threw his hammer at it; parenthetically without damage to the fox. On going to recover his hammer he noticed that it had bruised a rock, and that the bruise gave a bright metallic streak which the blacksmith supposed was due to lead in the rock. Subsequent investigation by some of the officials led to a sample being sent to Toronto where a remarkably high yield of silver was obtained.

VIEW SHOWING VEIN 49 AND OTHER WORKINGS ON THE NIPISSING, WITH THE SILVER QUEEN AND MCKINLEY-DARRAGH IN THE FOREGROUND.

At this time steel was not yet laid to Cobalt Lake, and little attention was paid to the matter or known about it until after Professor Miller's visit in November, 1903. Subsequent press reports and an extemporaneous address on the new ore field, illustrated with large samples of the ore, given by Mr. W. G. Miller at the annual meeting of the Canadian Mining Institute in Toronto, March, 1904, brought the matter to the attention of Canadians and made it evident to the public that a new, and possibly very valuable, ore field was extant in Eastern Canada.

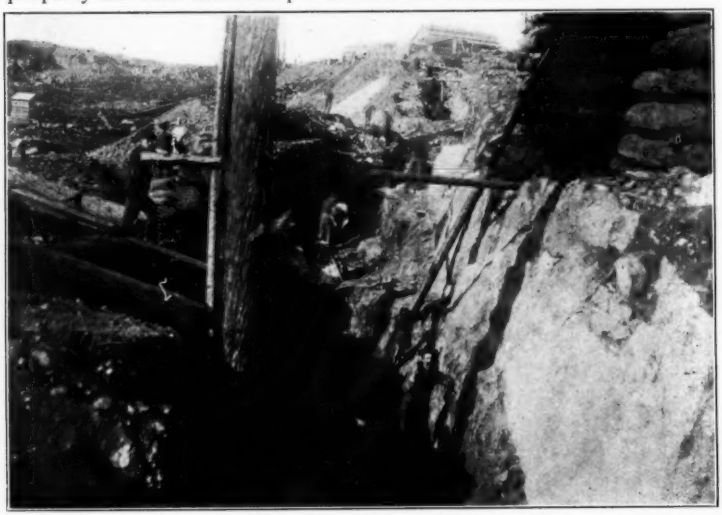
In the meantime two experienced Canadian prospectors who were familiar with that region, the Timmins brothers from Mattawa, and

THE ORIGINAL VEIN, KERR LAKE MINING COMPANY.

two railway contractors, the McMartin brothers of Cornwall who had had experience in British Columbia, had become interested in the reports concerning the new finds and, by purchase, obtained from LaRose the rights to the 40 acres of land which he had taken up from the Government. These gentlemen at once began work upon this property which has since attained an enviable notoriety as a producer; the "Timmins" mine being considered (and justly so) one of the best mining properties of this new district.

About New Year, 1904, or a little later, five local men formed a syndicate known as the Chambers-Ferland Company, who located 846 acres in the heart of the old Cobalt district. In the fall of 1904

these gentlemen sold out their rights for $250,000, to what is now the notorious Nipissing Mining Co. and Nipissing Mines Co., whose shares last fall displayed such a meteoric rise and fall, but whose property has such immense possibilities for the future.



VEIN 49, NIPISSING MINE.

Early in May, 1904, locations J. B. 7 and J. B. 6 were made by Mr. W. G. Trethewey who at once began operations on J. B. 7; this is now the property of the Trethewey Silver Mining Co. and J. B. 6 has been incorporated into the Coniagas Mining Co. whose peculiar but distinctive name is made from the chemical symbols of cobalt, nickel, silver, and arsenic—Co, Ni, Ag, and As.

These four properties just enumerated were the only ones to make any shipments during the year 1904; as a matter of fact steel was not laid, so that traffic from the town of Cobalt could commence, before the last week of October, 1904, and all the shipments made were sent out after the first of November. Nevertheless during those two months 158 tons of ore containing 206,875 ounces of silver worth $111,887 were sold and shipped. After this time discovery followed discovery in rapid succession, and the outlying parts of the district, such as Cross Lake and Kerr Lake, yielded valuable discoveries, so that the production for the year 1905 amounted to 2,451,356 ounces from 2,144 tons; and the production for 1906 has been given as about $4,000,000, from 5,129 tons. The total production therefore of this

new district is close to $6,000,000 for all the time it has been productive, which, as above noted, is practically but two years. Estimates of the production for 1907 are but mere guesses at this early date; nevertheless the greatly increased area over which profitable production may be expected make it certain that this year's yield will surely be double that of last year.

The increased area just spoken of comes from discoveries which have been made since July, 1906, at which time the productive area was limited to about five or six square miles. The discovery of the Bucknell and Mitchell claims on the south line of Casey township, that of the St. Denis near Martineau Bay, the Ontario Government's work, southerly, within the Gillies timber limit, and the discoveries on Portage Bay to the west have increased the area to more than 100 square miles, although it is now practically certain that such high values as have obtained in the older district will not prevail throughout the larger area; but this increased size of territory will lengthen the productive life of the field, because of the increased tonnage of low-grade ore which it ensures. At the present time low-grade ore, in the language of the camp, is anything less than 100 to 150 ounces of silver to the ton—a statement which will be surprising to many engineers in other localities to whom such a yield would be considered high-grade. In connection with this

THE CONIAGAS MINE SHAFT.

THE PETERSON LAKE DRAINAGE CHANNEL.

larger area it may be permitted to state that the resources in mineral of this northern country in the provinces of Ontario and Quebec are enormous and entirely unknown to the general public. Credible reports have been received of the discoveries of additional silver districts, of gold-copper deposits, and of free gold quartz, in this northern country; and it is known that the country south of this silver district contains several valuable bodies of iron ore, of copper ore, and perhaps of other varieties of silver ore.

The geology of the district has not yet been written in detail, nor can it be until greater development has been made. The earlier observers were justified, at the time, in making the statement that the ores occurred only in *one* series of the Huronian formation; but developments have shown that the values pass through all the series of the Huronian and, in some cases, through the Keewatin and diabase; witness the Green-Meehan and the University Mines.

Roughly speaking, the characteristic rocks of the region are the altered, ancient, plutonic rocks characterized as of the Lower Huronian period and consisting of conglomerates, agglomerates, breccias, and tuffs, with quartzites and slate in the lower portion: the greenstones and quartz-porphyries of the Keewatin age, and greenish to black diabase which is found not only as dykes and intruded masses in the agglomerates but also occurring as sills and overflows.

Much of the so-called conglomerate is more properly an agglomerate; it consists of angular, sub-angular, and occasional rounded fragments of grey and red granite in a mass of porphyrite or volcanic tuff. The fragments vary in size, the larger ones averaging on the exposed faces less than 3 by 4 inches, but the majority being under one square inch in area; the distribution of these fragments is very irregular and the angle of the beds is nearly horizontal.

This rock weathers to a greyish tint and in deep workings appears to become less, or non-fragmental. In some places the agglomerate passes into a fine-grained slaty rock which in turn grades into an impure quartzite. Through the conglomerates, and sometimes passing through and beyond the underlying diabase, or greenstone, occur calciferous veins carrying metallic silver and sulphides or arsenides of silver with smaltite and niccolite, the two latter minerals being the arsenides of cobalt and nickel. These veins apparently occur along the main lines of fracture by which the conglomerate has been shattered. The whole of the conglomerate has been split or fractured by a system of planes which cross each other approximately at right angles. These jointing planes near the veins often contain thin plates and filaments of native silver, and occasionally sparkle with minute crystals of the silver compounds mentioned above. It is along some of these jointing planes that lines of fissure follow, and are

THE SAVAGE MINE. SACKED ORE PILED AROUND THE HEAD FRAME ON THE RIGHT.

filled with calcite, smaltite, niccolite and the other characteristic minerals of the region, thus constituting the so called veins. The veins are not "true fissures" in the ancient and time-honored meaning of that word; they are rather openings occasioned by the cooling of the rock, or cracks occasioned by disturbances due to intrusion of the diabase.

THE SILVER QUEEN PROPERTY AND BOARDING HOUSE.

In places the cross-fracturing referred to has jointed the walls to such a degree that the mineralizing solution has penetrated to considerable distances from the vein, from 3 to 5 feet for example; in this way occur many of the thin plates or laminated sheets of metal, which, when mined in a large way, form the low-grade ore of the district, of which possibly a large tonnage will be made in the future. Some of the fissures or partings are found without this jointing in the walls, and in such cases very little or no second-class ore occurs. In other cases the larger fissures exhibit slicken-sided walls, and where the fractures are double, or run in pairs, (as is exhibited in the main vein of the Drummond property) they are frequently jointed by independent, and nearly horizontal, seams or veins which in the

instance mentioned frequently carried the highest values. Some of the veins in their vertical extension are subject to faulting by planes approximately horizontal, and the throw varies from 2 feet to 10 feet in the instances which I have observed. Several of these so-called veins do not reach the present surface but are "blind" veins, and are only found by cross-cuts from underground workings.

The limits of this article will not permit of descriptions of the individual properties from which the production of silver has been made, but from the experience they have afforded, it may be justifiable to infer that the richer and larger depositions of the valuable minerals assume the form of very much elongated lenses, dipping at a slight angle from the horizontal in the plane of the vein. The depth (on the dip of the vein) to which the rich lenses, which crop to the surface, carry varies apparently, from 60 to 80 feet, at which depth the zone becomes impoverished for 20 to 60 feet, the vein producing only low-grade ore. This low-grade ore is then replaced by another pay chute coming in, which continues for another indefinite distance, probably 50 to 60 feet, when it is succeeded by another lean streak, and so on. The deep shaft of the La Rose Mine, as I am credibly informed, substantiates this idea, and it is further borne out by the testimony of Mr. M. T. Culbert, the manager of the O'Brien Mine, given in a recent suit at law. Unfortunately for a sound generalization, the two mines mentioned are the only ones which have attained depths sufficient to justify any attempt to draw conclusions; one of these two mines is strictly closed to engineers for inspection and examination, and the other reaches its vein by means of cross-cuts from a vertical shaft, so that inspection of the whole vein to the present depth of over three-hundred feet is not possible. It therefore should be distinctly understood that the inference above drawn is one deduced from quite restricted premises.

As to the permanency of these deposits entirely different opinions have been expressed, but as time and experience are obtained the trend of opinion is distinctly towards a long life for the district. Mr. H. W. Hardinge has made an argument for the continuation of values to depths, from the premise of the large area over which mineralization is now found; substantially he says that, if the mineral came from one main source, and by the time it reached the surface impregnated an area of five square miles, leaving values in at least three overlying formations, then the source must be very deep. From such a line of reasoning great depths may be expected, particularly as a vastly larger area than five square miles has been mineralized, as recent

discoveries have shown. Time, and developments to the deep, are needed to give valuable information on this question.

That metallic silver diminishes with increased depth and that the sulphides tend to increase the depth has been observed in one or two mines, but it is also well-known that some of the surface veins which have yielded very high values have shown little or no metallic silver. At about 220 feet in the La Rose shaft the metallics are very much less in quantity, whereas argentite and pyrargyrite are much increased in quantity; at the Drummond Mine, at 130 feet from the surface, ore having no appearance of value yielded about 500 ounces of silver to the ton.

The fact that the lines of fracture are approximately vertical, that these lines as a rule coincide with the system of joint planes prevalent through the rock, and that the fracture lines continue below the surface agglomerate or conglomerate, are all facts in favor of persistence of the fractures or fissures in depth; whether values will be maintained in the continuous gangue matter is not so easy to predicate. But without question a camp or new district that has produced $6,000,000 in so short a time, which has energized Wall Street as did "Nipissing," and which contains ores which are richer (so far as quality is concerned) than those of any other known camp, is bound to have a noteworthy career, and to increase greatly our present knowledge of ore deposits in general, and of this class in particular.

HYDRO-ELECTRIC POWER VERSUS STEAM FOR INDUSTRIAL PLANTS.

By H. von Schon.

Mr. von Schon, in the article below, examines thoroughly into the comparative claims of fuel and of water power as initial sources of energy. In following issues he will show successively how the commercial and the engineering studies of a hydro-electric proposition should be made, summing up with a description of typical plants and a list of opportunities waiting development.—THE EDITORS.

IN the strife of men for betterment in industrial developments their leading thoughts and aims center in two goals—"economies of methods and perfection of output"—and of the means to this end no single factor plays a more important part than power.

Shaped in the minds and by the hands of Watt, Sickles, Corliss, Greene, Porter, and thousands of their worthy followers, the steam engine has become a thing of perfection, annihilating time and distance and making the apparent impossible a matter of fact. But another Richard entered the arena when electric energy was brought under practical control; the autocracy of steam as the supreme power agent was challenged, fought, and for aught one can know today, may be doomed to defeat at the hands of this mighty rival.

And, now in our day we are approaching the third milestone in power history, the distant transmission of electric current, the perfection of which not only threatens to put steam as a power agent in the second place of importance, but reaches out boldly for the crown worn so long and undisputed by King Coal as the prime source of energy, and may force his late majesty to restore to old Neptune some of his former glory in moving the wheels of industry. And thus today the world's search for economy and perfection is not only as to the power applied to the work, but may be extended with good promise of reward to the further inquiry for the prime source of energy. To subject this query to a searching analysis is the intent of this series of articles, which are written for the purpose and with the hope of leading the men who project and exploit industrial enterprises to recognize its far-reaching importance as being one of the basic conditions which, in co-operation with others, must be correctly determined in order to insure the greatest practicable commercial success.

Steam vs. hydro-electric power or, more to the point, fuel vs. water-power energy, is the subject to be weighed, and primary and fundamental to its discussion steam vs. electric current must be arrayed, as water power and electric energy combined, and made one in their effective work, must fall or stand together in a claim of supremacy against steam power.

What are the important features of the power plant and its service which contribute to the successful operation of a shop or mill? They may be grouped under four heads:—availability, adaptability, efficiency, and cost.

The power must be constantly available; should it fail for any reason whatever the shop or mill ceases to operate.

The cause of failure of a steam plant may be want of fuel. The fuel resources of the world are very large but they are not generally distributed, and even their proximity is no guarantee of continuous supply, as other agencies must be reckoned with. Producing and transporting the fuel is one of the most important enterprises of this day; the organizations caring for it are complicated and not always reliable; strike and car shortage are of recent occurrence, and not only has the fuel supply at times in recent years been aggravatingly uncertain, but the reader will recall the fact that only last winter a large portion of the western United States was not only without fuel for shop and mill operation, but great hardship was caused because no coal was obtainable for the heating of houses. This was not caused by strikes, but because the great transportation lines, which the world justly holds up as models of organization and enterprise, these all powerful carriers for weeks and months could not command cars to carry coal to the suffering West.

What guarantee then lies in the million-ton deposit or the million tons mined, if means of bringing it to the point of consumption are uncertain?

A few years ago the mining of coal ceased in the United States for weeks and months because the operators and miners disagreed, not only on questions of wage, but on matters of management, in which the laborer of today claims and is granted a large voice. Are there any assurances that labor and transportation of the future will guarantee a more constant supply than in the past? At best this seems doubtful.

Power may not be available because the plant needs repairing. A steam plant consists of many parts, chief among them the boiler and the engine, and appurtenant to these are the feed pump, water softeners, water heaters, stokers, condensers, injectors, and other

minor equipment. All these are refined machines subjected to severe strains and in parts rapidly wearing. Furnaces have to be relined frequently, grate bars renewed, pumps and engine repacked, and the boiler itself at best is but short-lived; often such repairs take hours and days, and unless the plant contains spare units, delays of continuous power service are a certainty under the best conditions.

Individual machines in shop or mill may be stopped for want of motive power on account of repairs required by the mechanical drive by which the power is distributed; line shafts, hangers, pulleys, belts, all need frequent attention and periodical renewal.

Subjecting hydro-electric power to a like examination as to availability we find that it requires no fuel; its energy source is falling water. That "the mill will never run with the water that has passed" is a perversion of the facts, since the endless chain, from clouds to river and ocean and by evaporation back to clouds, represents the law of Nature.

This supply is distributed over all sections; every stream represents such energy. It is probably true that water power in many minds is associated only with a water fall, but as a matter of fact the most sluggish stream represents, in the practicable accumulation of the fall required for its flow, water power. In Germany today water powers are being developed with falls as low as three feet.

The available supply of this energy is as unknown as that of fuel; it is everywhere, and its availability for power production, when once harnessed, does not depend upon the good will of labor organizations or the facilities commanded by transportation lines; its continuity of supply is beyond the influence of human agencies; it is regulated by Nature's laws only. It is not within the argument that this supply may be uncertain because of low-water condition, since it has been assumed that the boiler capacity is sufficient for the engine output, and that of the latter for the work to be done, so the assumption holds that the water-power development has been correctly planned in accordance with the available flow as replenishable from guaranteed storage.

A hydro-electric plant rarely causes delays due to repairs or renewal of parts. The generating part consists of water turbines, exciters, and generators. The first are practically automatic; at least they are known to have run continuously from beginning to end of year without stop or repairs; the generators are likewise complete in themselves, requiring no repairs; the transmission plant consisting of transformers and line brings the current to the shop and mill, and when it has been constructed with reasonable care, it is

constantly serviceable. There are no mechanical drives of shafts, pulleys, and belts, each machine taking power from its individual motor. The wiring is permanent. The supply and service of a hydro-electric plant is therefore continuous and constant.

The second important feature in a power plant is its adaptability to the operation of shop or mill.

The steam plant must be located in close proximity to the work; it requires considerable space for fuel storage, boiler house, and engine room; it must be connected by tracks to some transportation system. In fact, the requirements of the power plant, not those of the industry, determine where it shall be located, and in many cases this condition is a positive disadvantage.

As to the application of the power itself, we have already mentioned the mechanical drive by which it is distributed, which practically fixes the arrangement of the machines and tools—irrespective of the demands of the process peculiar to the character of the work to be done—in straight lines parallel to the shafting. The presence of many pulleys and belts is a great hindrance to ready access to the apparatus, and the dust and droppings of oil make it difficult to keep the shops in anything like a cleanly condition, while the air is impure from the same cause and the great noise of all these operating fixtures does not contribute to orderliness and comfort. The speed for which a machine or tool is belted cannot readily be varied and, as a rule, it is not as high as could be utilized to advantage. Fast drives increase the output materially.

All this is different with electrical power; in fact, all these objectionable features are removed and advantages are added. The shop may be arranged absolutely to suit best the process; it may be, as is frequently desirable, divided into departments located in different buildings; each machine and tool has its individual motor—no shafts, pulleys or belts; no dust or uncleanliness, no noise or odors; each machine can regulate its own motor speed, the output is increased, and the shop may be expanded by adding tools whenever needed without regard to fixed arrangement of drives, as a wire splice is all that is needed to furnish power to another machine. The industry may choose the best location for its purpose, taking advantage of a desirable lot or rental of suitable building and, in fact, the enterprise may be planned without regard to power requirements.

Efficiency is the third consideration.

With steam power the efficiencies of boiler, engine and drive must be considered. That of the boiler depends upon the quantity of steam generated by one pound of fuel per hour, and the condi-

tions influencing this result are quality of fuel, design of boiler, quality of water, and method of firing.

Many tests have been made of boiler efficiencies from which a considerable range in efficiencies, due to both fuel and to boiler design, is apparent, and to these must be added the other influences due to quality of water and method of firing—especially the latter, which largely controls the efficiency and depends wholly upon the care of the operatives.

The efficiency of the engine is the next factor; it is expressed by the quantity of steam required for the generating of one horse power, which depends upon the design of the engine, as securing the greatest amount of energy from the available steam and offering the least amount of mechanical friction. The source of the engine's work is steam pressure, which is in direct proportion to its temperature. From this is clear that the ratio of utilization of all the available pressure determines the efficiency. At best the range of temperature of steam is small, since it rapidly liquifies, which latter process is accelerated by its expansion. The important difference in engine types therefore deal with the conserving of the greatest quantity of steam pressure, which is greatly enhanced by condensation, after expansion in the cylinder. The two large classes of engines are therefore the non-condensing and condensing type, each of them being represented by many different designs and their efficiencies covering a wide range.

It is also proper to notice the effect upon engine efficiency exercised by the boiler, since the pressure or temperature of the generated steam supplied to the engine is the basic condition.

From many tests it appears that from 12.3 to 33.4 lb. of steam are required to produce one horse power per hour, depending entirely upon the type of engine, and this range may be furthermore increased by faulty conditions of engine parts or careless operation.

The third factor making up the efficiency of steam power for shop or mill operation is the mechanical drive, by which the power is transmitted and applied to the machines and tools. Some experiments by C. D. Gray, at Cornell University, show the following results:—

Power Application.	Efficiency of Drive, in per cent.
50 Cotton or Woolen Mills,	74
17 Machine Shops,	45
319 French Shops,	60
Wood and Metal-Working Shops,	65
Heavy Machine Shops,	55
8 Large Factories in U. S.,	56
3 Mills (full load),	56
6 Mills (half load),	45

These values are for the ratio of power taken from the shaft of the machines to that put on to the main shaft at the engine, and include only the loss in belts and shafts.

There is one other factor, and perhaps the most important in relation to efficiency of output, especially when considered in connection with operation of shops and mills; that is the constancy of efficiency under variations of load, and it is in this respect that the parallel here drawn is most seriously thrown out of balance. A steam plant's highest efficiency is that at full load, and it falls off rapidly with the decrease of load. For an engine of 1,000 horse-power capacity the following are the efficiencies with decreasing load:—

Load.	Output in Horse Power.	Efficiency, per cent.
Full,	794	79.4
Three-fourths,	544	72.5
One-half,	294	58.5
One-fourth,	44	38.1

The normal constant loss in belting and shafts is 206 horse power; and it must be borne in mind that this represents engine-output efficiency only, not that of the entire steam plant.

This closes the efficiency discussion of steam plants, though there are several minor influences tending to lower these efficiencies which it is not necessary to touch upon.

Contrasting with this exhibition the performance of a hydro-electric plant, it is first to be observed that the power value of the source of energy is fixed by the immutable law of Nature, that is by the product in foot pounds of the weight of water and its fall. It never changes; water weighs everywhere—for practical purposes—62.5 pounds per cubic foot, and this multiplied by the number of feet of its fall is the energy, and its efficiency as the energy source can therefore be fixed at 100 per cent,

The agency by which this energy is converted into mechanical power is today universally the water turbine. There are only two types, the reaction and the impulse turbine, their different characteristics being indicated by their names, though there are several known patterns of each, their chief difference being that they are manufactured in different shops; their characteristics are practically alike, variations being only of details of construction. This turbine, as the converter of the prime energy into useful work, takes the place of the boiler, engine, and all their appurtenant equipment, and it is complete in itself and the only and final mechanical device by which the mechanical power is produced.

The practical working efficiency of any of the modern turbines is 80 per cent, though much greater claims are made by the makers.

This mechanical power is converted into electric energy by the agency of electric generators which, in the large majority of cases, may be direct-coupled to the turbine shafts. There are two types of generators, the alternator and the direct-current machine, differing only as to their characteristic output of current, but for the purpose of this discussion only the first class need be considered, as the other is not available for transmission duty. There are various makes of generators, but their differences in design and character are even less pronounced than those of turbines. They are complete, with the addition of the exciter, in performing the conversion of mechanical into electric energy and their efficiency lies between 92 and 96 per cent.

This, then, completes the entire generating plant of hydro-electric power, with a net efficiency of 75 per cent of the prime energy.

Its application to the operation of shop or mill is by means of transmission of generated current which, within a distance of fifteen or twenty miles, may be accomplished without any further conversion of current characteristics or voltage, and therefore without other equipment excepting the transmission line, consisting of copper wire suspended from poles with proper safeguards of insulation. The loss of energy—drop of voltage—in this line may be from 5 to 10 per cent, which is entirely controllable by the size of copper wire in the line. And now the current is at the point of application to work, and is led to the machine or tool motors by a wire, and there represents the comparative efficiencies of 100 per cent of prime energy against the fluctuating heat value of fuel, and 68 per cent in working power of this energy as against 10 per cent developed by the engine out of steam.

The losses from this resultant electrical power in its application to useful work are those due to transforming, lowering its voltage, of about 3 to 5 per cent, and those in motors, about 4 to 7 per cent, leaving a net working efficiency of 88 to 90 per cent as against an efficiency in mechanical drive of from 45 to 78 per cent.

Last in the efficiency discussion is the constancy under varying loads which, as already foreshadowed, presents for the hydro-electric power an overwhelming advantage.

A water-turbine's rated efficiency is that of operating with three-quarter gate opening, and its range from that to full or half gate operation lies within 2 to 5 per cent, or in other words, the turbine's efficiency at any point between full and half load should not fall below 75 per cent. The same is true of the electric generator, which is especially designed to meet load fluctuations efficiently; the range of efficiency, from half to 50 per cent overload, will not be more than

10 per cent. The above claim of the remarkable difference in this respect between steam and hydro-electric power will readily be recognized by comparison of these losses and the losses quoted for decreasing loads in engines.

And now we reach the crucial, the most essential test of all, the cost of power. It is easy to foretell the factors which will be marshalled to proclaim the unquestioned superiority of hydro-electric power on this account. Cost of generating, operating, maintenance, depreciation of the actual output utilized and of plant are the main heads.

In considering these several features, to make a fair comparison, the parallel must be carried along one plane as to the character of the plants, which should be for the steam plant one of perfection of apparatus and equipment comparatively equal to that of an ordinary water-power plant. Turbines of today compare fairly in effectiveness of output only with the highest type of boilers and compound condensing engine plant.

It would be difficult to find another subject of importance to the industrial operator like that of the cost of his steam power, in regard to which he has less accurate knowledge. Of course the amounts paid for the boiler, engine, pumps, etc., and for coal and wages are known—but what about interest, water, taxes, insurance; about repairs, renewals, supplies and incidentals, and last but not least, depreciation? Are these items all properly charged? And most important of all, what is known of the actual horse power used, or in other words, the load factor of the shop? For all these items, apparently small, become large when the load factor fluctuates. It results, therefore, that far the most general impression is that the cost of power is about half the actual, or even less than that.

The generating cost is made up first, of fuel and water, the quantity and cost of which are as follows, at the very economical fuel consumption of 1.5 pound per horse-power hour and for 10-hour operation for 308 days;

Plant, Horse Power,	25	100	300	500
Tons of Coal,	57	231	693	1,155
At $2.00	$114.00	$462.00	$1,386.00	$2,310.00
" $2.50	$142.50	$577.50	$1,732.50	$2.887.50
" $3.00	$171.00	$693.00	$2,079.00	$3,465.00
" $3.50	$199.50	$808.50	$2,425.50	$4,042.00
Gallons of Water	140,000	567,000	1,702,000	2,836,000
At $0.10 per 1,000	$14.00	$56.70	$170.20	$283.60

The second item of cost is that of operating, being made up of wages, oil, waste, and disposal of ashes.

The operating force depends upon size of plant, but unless this is very small it will generally require an engineer and a fireman, and

their wages will be about $90.00 per month for the former and $2.50 per day for the latter, being a total of $1,950.00 for the year.

Oil and waste is a somewhat uncertain item, depending entirely upon the care of the operators; it may be charged at $700.00 for a 500 horse-power plant per year, with a slightly decreasing ratio for larger and an increasing ratio for smaller plants.

Disposal of ashes is also an uncertain item; sometimes they can be used for fills and do not involve cost; in some cases they have to be carted off at some expense, but no charge will be made on this account in this instance.

Maintenance is the great unknown quantity. In this category must be placed all the repairs and renewals to buildings, stack, boiler setting, boiler flues and shell, furnace lining and grate; packing of pumps and engine, renewal of bearing linings, cylinder heads, and painting. $1.00 per horse-power per year during the first two years and a gradual increase of $0.50 per year thereafter is considered a normal maintenance charge under careful operation of plant.

Depreciation of plant is generally entirely ignored in estimating the cost; nevertheless there is very little doubt that the plant wears out, that boilers must be replaced by new ones in ten or fifteen years, that pumps and engines do not last forever. What is an old steam plant worth—what can it be sold for? Experience points to a depreciation charge of 5 per cent as a very conservative one on the type of plant here considered.

And then the vital item, the cost of actual output utilized, or, in other words, the ratio of cost of the power producing work to that of the entire output. A 250 horse-power engine requires its full capacity steam no matter what portion of its output is used; the full amount of coal is needed for generating the steam; the wearing and therefore maintenance and depreciation charge remains the same as does that of wages. If, therefore, only 125 horse power are doing work the cost of each horse power is that of 2 horse power generated. When the shop closes for the noon hour steam must be kept up, and indeed in most plants fires are kept up 24 hours for 10-hour operation.

There are no shops and few mills which represent a 100 per cent power load; the former will rarely exceed an aggregate of 60 per cent, the latter of 80 per cent.

The last item is that of plant itself. The cost of buildings, of course, is variable. Cost of boilers, set, is about as follows:—

Plain Tubular,	From $12.00 to $16.00 per horse power
Water-Tube,	" 15.00 " 20.00 " " "
Pumps, non-condensing,	2.00 " " "
Condensing,	4.00 " " "

The cost of engines is about:—

Simple Slide-Valve,	From	$7.00	to	$10.00	per	horse	power.
Simple Corliss or Slow-speed,	"	14.00	"	20.00	"	"	"
Compound Slide-Valve,	"	15.00	"	18.00	"	"	"
Compound Corliss,	"	22.00	"	26.00	"	"	"

Generating hydro-electric power does not require any fuel nor is the water in that sense a charge, as it pertains to the riparian ownership, and therefore it might be correctly said that there is no generating cost.

The operating cost is made up of wages, oil and waste.

For moderate sized plants the operating personnel consists of an operator, at about $90.00, and an attendant, at $60.00 per month, at the generating end, and a similar force at the distributing point. In this connection it must be borne in mind that such a plant as a rule takes the place of several individual steam plants. The quantity of oil and waste required will be considerably less than for a steam plant, as only the electric machines require lubrication. There are no ashes to be disposed of.

A realistic appreciation of the economy in operation of a hydro-electric power plant is forced upon any one who will visit such, as for instance, the plants at Mechanicsville, Massena or Niagara, representing a power output of from 20,000 to 100,000 horse power with from four to a dozen operatives. I designed and constructed the 50,000 horse-power plant at Sault Ste. Marie, Mich., which at present consists of an equipment of forty-two units of 500 electrical horse power each, with a turbine installation of one hundred and sixty-eight wheels. The operating personnel is made up of one superintendent, one operator, and four laborers. The power output, if steam, would require 378 tons of coal daily and probably one hundred men to handle it and do the firing.

The maintenance and depreciation of a hydro-electric plant is insignificant as compared with that of a steam plant. The works of modern construction are permanent and require no repairs or renewals; the turbines are of simple mechanism and no part of them is likely to wear much or to be injured; the electrical equipment is likewise durable, and the transmission line only is subject to damages from the elements, and therefore requires maintenance.

A summary of these items for a 1,000 horse-power plant is as shown on the following page in tabular form. The cost of operation is seen to be 25 per cent less for the hydro-electric than for the steam plant. And yet if anything, this comparison greatly favors the steam plant. Fuel consumption at 1.5 pounds per horse power hour is low

for 90 per cent of steam plants; more frequently it is double that, and even greater, and maintenance charges grow rapidly as the plant ages.

Plant.	Steam.	Hydro-electric.
Buildings and Works,	$10,000.00	$40,000.00
Boilers, Pumps and Engine,	50,000.00	
Turbines and Generators,		15,000.00
Transmission, 20 miles,		40,000.00
Mechanical Drive,	5,000.00	
Distributing Equipment,		10,000.00
Total Investment,	$65,000.00	$105,000.00
Charges.		
Capital Investment, 5 per cent.	$3,250.00	$5,250.00
Fuel, $2.50 per ton,	5,775.00	
Water,	566.00	
Operation (three Firemen),	3,390.00	3800.00
Oil and Waste,	1,300.00	500.00
Maintenance and Depreciation,	3,750.00	3,200.00
Taxes at 2 mills,	1,350.00	2,100.00
Insurance,	650.00	
Total Operating Charges,	$20,031:00	$14,850:00

Applying ordinary efficiency of output, the cost per horse power at the machine per year, for the two systems, is:—

	Steam.	Hydro-electric.
At 100 per cent. load factor,	$25.50	$17.50
" 75 " " " "	36.90	22.90
" 50 " " " "	67.75	33.00

This is for shop power plants operating 10 hours; a similar tabulation for mills running 24 hours is:—

	Steam.	Hydro-electric.
Capital Investment,	$3,250.00	$5,250.00
Fuel,	11,550.00	
Water,	1,132.00	
Operation,	6,780.00	7,600.00
Oil and Waste,	2,600.00	1,000.00
Maintenance and Depreciation,	3,750.00	3,200.00
Taxes and Insurance,	2,000.00	2,100.00
	$31,062.00	$19,160.00

Here, again, the steam plant is quoted too low, as it must include extra boiler units to guarantee continuous operation. The cost per horse power per year will be, for

	Steam.	Hydro-electric.
100 per cent. load factor,	$39.12	$22.40

Thus far the discussion has concerned itself chiefly with the power plant of the individual shop or mill. Centralization of efforts and forces, of capital and organization, has been the keynote of the industrial development of the last decade, Central power plants are the logical application of the principle in the field we are studying. No other factor is so far-reaching in securing economical power as the displacing of the individual shop or mill plant and the substitu-

tion of central-plant service, which must be of electric current. By this evolution the industrial plant becomes emancipated from many of the serious disadvantages adhering to the individual power plant, which have already been enumerated in discussing adaptability, while it may enjoy the boon of paying only for the power actually used.

A central power plant is among the best assets of a growing town; enterprises can be established without considering the investment in a power plant, may be located without special regard to fueling facilities, and by their comparative cleanliness will attract a better class of operatives; nor is the influence on the sanitary conditions of the community to be minimized.

The electric current accomplishes all this for the shop and mill, and hydro-electric power is the ideal consummation for the central plant. A steam central plant is after all limited in its scope, while most water-power installations are capable of expansion by the addition of power units, the works being suitably designed.

It is quite likely that many of the readers of this article will hesitate to admit the plain conclusion that hydro-electric power represents the ideals of economy and perfection sought for in a greater degree than any of its rivals, and such hesitancy is warranted by obvious conditions. Only a decade or so has passed since hydro-electric power became a recognized rival of steam, and it is not remarkable that much that concerns it is yet enveloped in somewhat of a mystery. This fact is perhaps more sharply revealed to those who devote themselves entirely to its service, and therefore are constantly within the sphere of its influence.

It is certainly a fact that hydro-electric power development is today considered by many well informed men of industrial training and experience to be an experimental, uncertain, and speculative undertaking, characterized rather by chance and accident than reliability and permanency. In my judgment this impression prevails because the time since hydro-electric power has forced itself to the fore has been too short, its bringing out, so to speak, is too recent for men to take full knowledge of its character and of the required treatment to develop and control it successfully.

Water power, *per se,* has hardly ever received serious book treatment either from the commercial or technical point of view; such matter as has been published is scattered through text books, pamphlets, or manufacturers' catalogues; this is especially true of its history in the United States.

During its first period of utility, now well past, which may be termed that of the isolated mill power, developments required no

searching investigations either as to supply or application; there was always sufficient water for the purpose, and if it failed at times it mattered little; the demand was represented by the mill. Nor did its planning call for special engineering skill. The works were of the crudest type and construction; they had low hydraulic efficiency, and the application was for an isolated mill, not a distributing power plant. These developments were good enough for their service, which did not call for refinements, economy and efficiency. Nor were these undertakings of large scope requiring important investments. The millwright planned and constructed them and little of his art got into public print; it was by the rule of thumb rather than scientific principles that they were created.

Then came the second period of water-power distributing plants, where conditions favoring the establishment of an industrial center near a large water-power opportunity existed. The works of these were important, were planned by engineers, and represent a high degree of excellence for that period. But, even then, little consideration was given to the securing of the greatest and most efficient hydraulic output obtainable from the available factors; the purpose was solely to distribute the water with the fall to separate industries, or to group the formerly isolated mills at one site. These undertakings were few in number, as the necessary favorable conditions were only rarely found in one place, and they concerned only large developments. Some of these were described in pamphlets and periodicals but no concise treatment of the subject as a whole came forth.

Then came the present period of hydro-electric developments, when water power is converted into electric energy and the output transmitted to distant points to perform any and all functions of applied power. It is no longer a question of mill sites, but of available distant market and a water power to supply its demands. Water powers never before considered now become eligible, first those of large outputs near important industrial centers, but as transmission problems have been more and more developed smaller powers have become available, until at the present time nearly every water power may find its useful field; hundreds are now under construction, other hundreds are projected for early development, and many more remain as yet unexploited.

In this, its present field, water-power development has assumed a new aspect differing materially from its former status. The purpose now is always to secure the largest, most economical, and most efficient development of the opportunity, which necessitates the correct estimating of the available power factors and the planning of a devel-

opment by which the most remunerative output can be secured. Now it has passed into the specific realm of the hydro-electric engineer, on whose diagnosis of the hydrographic characteristics, estimate of output, designs of works, and equipment to the point of delivery, the success of the undertaking solely depends. Formerly the power site was fixed by mill location and operation facilities; now no such influence exists, and the power location may be and should be determined purely from the consideration of best development; this suggests a much more thorough search for the most favorable topographical and geological conditions and calls for the judgment which readily recognizes those natural features which influence the character and cost of development. The determination of the available flow is now one of the most important subjects, and its solution requires a correct appreciation of drainage-area characteristics, precipitation, evaporation, and the opportunities of storage.

Such an investigation was rarely a part of former water-power developments, and its importance is even now frequently overlooked. Therefore, it is the rule rather than the exception that the available flow is overestimated, especially for the preliminary stages, which constitute the period when the commercial value of the enterprise is first quoted. The result is disappointment, if not serious losses, when the later more thorough investigations fail to substantiate the preliminary estimates.

The works of these developments are now planned in accordance with the most modern scientific principles of conserving the greatest percentage of the power factors, and utilizing them by power agents of the highest obtainable efficiency, and in this sense the output must be planned for its ultimate purpose, the transmission of electric energy. The field now embraces hydraulic, mechanical, and electrical engineering, the study of the stream's hydrography, determination of the power factors, diagnosing the power opportunity, and deciding upon the most suitable development programme; and the planning of works and designing of equipment and of transmission plant. Thus has been developed a new specialty of engineering which has heretofore not been treated in one publication.

The promotion of hydro-electric power projects has been and is now being considered a fruitful field, and in the hurry and pressure, or for reasons of short-sighted economy, their exploitations have been very largely a matter of surface treatment resulting in erroneous and deceptive impressions. This experience is largely responsible for the want of confidence with which such projects are received by the conservative man of business and of capital.

PROFIT MAKING IN SHOP AND FACTORY MANAGEMENT.

By C. U. Carpenter.

IV. THE GREAT IMPORTANCE AND VALUE OF TOOL-ROOM REORGANIZATION.

Mr. Carpenter's series began in January last and so far has dealt successively with the mode of examining into the conditions of a manufacturing business so as to discover the "sticking points"; the institution and working of the "committee system," and the reorganization of the designing and drafting department. Next month he will take up methods and processes for machining operations and the determination of standards of efficiency in production.—THE EDITORS.

IN the preceding article of this series, which appeared last month, I advanced the proposition that the essential preliminary step in the reviving of a run-down concern is the thorough reorganization of the designing, drafting, and tool rooms, along rather new lines. The necessary conditions to be secured in the first two departments were fully dealt with and the functions which the tool room should exercise toward the manufacturing processes at large were outlined.

In order, however, that the tool room, by its organization and equipment, may be enabled to lead the shop toward the goal of manufacturing success, it must itself be instituted for the highest efficiency and economy in the production of tools. I feel that too much emphasis can not be put upon the conception that this is the place to begin the work of reform, by close examination of the existing conditions and rectification of existing defects. It remains, then, to show how the maximum possibilities of the tool room may be realized. My suggestions are the result of experience in a number of very trying cases of factory inefficiency, and the remarkable results coming from the adoption of the plans described fully justifies strenuous insistence upon the statement that this is the real starting point for the campaign of improvement.

TOOL-ROOM METHODS.

The conditions surrounding tool-room work often make it difficult to apply the same methods toward the hastening and cheapening of production therein which might be applied to the production departments. Day pay is the usual rule. Owing to the character of the work, any other wage system is generally impracticable, and even if practicable would be inadvisable because of the necessity for accuracy.

Nevertheless, even granting the difficulties that beset one in trying to apply the principles of cheap production to this chief agent of progress and economy, the tool room itself—still, so high is the expense per man when compared with that prevailing in the balance of the shop, so costly may the tool-room product run, of so great importance is *rapid* production, and last, but by no means least, so many are the opportunities for "laying down on the job" without the possibility of detection of any such costly tendencies—that some comprehensive plans *must* be adopted, first, to ensure the cheapest possible methods of production, and, second, to check up foremen and workmen properly as regards costs and accuracy. If these points are properly covered, the *rate* of production will care for itself. Such a policy is especially necessary in the care of the run-down concern with an inefficient or "slow-gaited" tool-room force, whether the tool-room force is a large or small one. For, to state an important point which I shall want to emphasize, we must always keep in mind not only the possibility of wasted money through excessive tool costs, but also, and indeed *especially*, the waste of valuable time in securing tools by the use of which large sums can be saved in the shop.

We must, of course, assume that the tool room is supplied with a full equipment of high-grade machine tools.

First get a first class, high-grade tool-room foreman. This cannot be emphasized too strongly. Do not plan a campaign of improvement with any expectation of a satisfactory outcome unless this first step is taken. Well paid, high-grade mechanics are, in the end, the cheapest labor for the tool room. The mistakes of the low-wage workman are too costly. Owing to the high hourly rate of the tool maker, thorough organization in the tool room is necessary in the interest of low costs and rapid production of the tools themselves; but beyond this, is the great importance of getting the new tools into service. Delays are doubly costly, as already pointed out; and yet unless the tool room is well organized and systematized, it is often more productive of "unaccountable delays and disappointed hopes" than of the new and much needed tools. The dilatory movement of the ordinary tool room constitutes one of the most trying experiences of the factory manager.

In the older types of shop, even where large forces of tool makers are employed, the practice of allowing the expert high-priced workman to machine up and fit all the component parts of a single tool and then assemble it into the finished product still prevails. Under such conditions, this high-priced tool maker will be found machining up jig bushings, legs, special screws, and other parts of special tools that can

be easily standardized, and in many cases will be turning out in small quantities work that should be handled on stock orders and turned out in large quantities by much cheaper labor at a fraction of the cost.

The similarity between this method of building tools and the old-time methods of building the finished machine for the market is striking. But just as the old-time method of construction in the case of the finished article was found too slow and costly for modern conditions of trade and competition, and has been rapidly supplanted by comprehensive plans for standardization, duplication, production in quantities and careful supervision of labor, just so the old-time tool room methods are being changed so as to take advantage of these obviously economical steps in the building of costly tools.

Standardization.—A tool-room force working under the old-time methods just described will produce in the course of a year sets of tools that are distinguished chiefly by a great lack of uniformity and absence of any attempt at standardization. Yet a close study of the ordinary shop tool conditions and requirements will prove that the standardization of many parts is possible if only a thorough-going attempt is made to effect it. This applies particularly to those shops where the tools are of the smaller sizes. For example, in the case of drill jigs, such parts as bushings, legs, stops, screws, pins—and even the bar stock—can be standardized to a comparatively few sizes.

Duplication.—Once this is done the duplication of these parts in quantities and the keeping of them in the stock bins for immediate use becomes possible. The savings are at once apparent. First, a large reduction in the initial cost results because of this production in quantities, and that too by a much lower priced workman than the tool maker. Again, the possibility of always having these parts on hand when wanted by this tool maker will invariably result in a large saving in both first cost and time.

Subdivision of Labor.—The modern practice tends therefore toward the same rigid subdivision of labor in the tool room that exists in the production department. The high-priced tool maker does no work that can be performed by cheaper men. Not only are those parts that can be standardized and machined in quantities produced by a less expensive class of labor, but also much of the closer work in milling, turning, grinding, etc., is often handled by special men who do no other classes of work. Thus the tool maker, instead of laboriously producing each and every part of any tool at great cost and loss of valuable time, becomes an expert adjuster and assembler, receiving promptly from various sources many portions of the tool he is to

finish, these parts requiring simply the finishing operations at his skilled hands to bring them "to size."

In one large shop under my management, where conditions were unfavorable, we applied these rules of subdivision of labor and standardization to great advantage, especially in the building of large numbers of small drill jigs. The screws were standardized. All stops, legs, and other small parts were turned out in large quantities on the automatics. The bushings, also manufactured in large quantities, were turned into stock in such condition as to require simply the finishing operations by the experienced tool maker. Even the bar steel forming the top, bottom, and sides of the jigs, was finished to standard dimensions, cut off to standard lengths, and placed in stock for immediate use. The tool-designing department followed closely this scheme of standardization, the result being a large saving in tool costs, even though at times slightly more metal was used in the jig than was required by either the part to be manufactured or the character of the operation. This extra cost was saved many times over in the lower wage cost, due to the fact that the high-priced man had only a few finishing operations upon the component parts of the tool, and thus became an assembler and adjuster to a large extent.

In addition to this pleasing reduction in cost, there ensued a still more satisfactory increase in the output of greatly needed tools from a department handicapped by lack of room and of high-grade tool makers.

The Small Shop.

In the case of the small tool room of very few men such subdivision of work is often impracticable. But even in a department composed of four or five men, common horse-sense methods applied strictly to their work will result in a saving in both money and time that is of great importance and fully proportionate to the savings in the large departments. In shops where the tool-room force is a small one there usually exists a tendency to ignore this part of the organization and let it get along as best it can. This is a vital mistake. In the first place, the tool-room force is seldom half large enough considering the great value of its work. Again, the relative importance of this department in the case of the small plant is fully as great as in the case of the large company. Its work bears the same relation to cost, accuracy, and quickness of production in one case as in the other. Whether the department be small or large, the same methods of organization, division of labor, and of checking up tool costs can be used to great advantage.

Methods of Increasing Speed of Production and Checking Up Cost.

Lost time in the tool room, as already pointed out and emphasized, is a more serious matter than in any other department in the shop, since delay in the production of a tool means not only a high rate of increase in actual cost of that tool, but may often involve a continuation of a shop loss which could be avoided were the tool in use—a loss often many times the cost of the tool itself.

The importance of adopting up-to-date methods for increasing tool-room production and for checking up and lowering costs then seems obvious. And yet the lack of effort to accomplish these results in most well run modern shops (to say nothing of the poorly managed) is as singular as it is prevalent. The belief seems to prevail that the cost of a tool is too difficult a matter either to estimate or investigate. And yet the admission of the fact that it is a difficult question to solve makes the possibilities of loss in many directions the more apparent, the need for some method of removing them the more pressing.

The special conditions make the problem a hard one. The work is usually altogether special and must be done upon the day-work basis of pay. The difficulty of securing proper economical results from this day-work system often leads to lax methods in administration and management. The amount of time wasted by workmen under the day-rate system, unless they are rigidly supervised, is astonishing. Only an approximation to a "few days work" is often secured with difficulty. Even rigid supervision avails but little unless it is supplemented by some system that will prove a spur to the men—some system through the use of which the good men may feel that there is an opportunity for recognition and reward, and laggards may know equally well that if they do fail to produce work in a reasonable length of time they will surely be noted for punishment.

Tool Cost Card.

The tool-room system advocated here depends upon the determination (by estimate) of the proper tool-room costs, item by item operation by operation, *before work* begins upon the tool; and then, after the tool is completed, the *comparison of the actual with the estimated costs,* and especially the noting of the records of the rapid and the slow workmen as shown upon the cards.

The card on the following page is self-explanatory.

Form of Card.—The form given is merely suggestive. In some cases, the division of "operations" is unnecessary. In other cases,

Tool Record Card

Tool No._____ Drawing Nos._____

_____

_____

Name of Part_____

Name of Part of Tool	Operations	Estimated Costs	Actual Costs	Name of Workman	Remarks

Total Costs Labor_____

" " Material_____

Complete Cost_____

This Tool must be completed by_____

Date of Completion_____

If any delay, Why?

Special Instructions

Design and Estimated Cost Approved by

Tool passed by Committee_____

Sig. of Sec'y_____

SUGGESTED FORM FOR TOOL COST AND RECORD CARD.

they are important. In most cases, the total time in which the work is actually done can be placed upon the card after the operation is completed; inasmuch as the man has before his eyes a statement of what *should* be done, he will know what he is accomplishing in the way of speed of production and he is certain that his record, be it good or bad, will "go up to the front office." Immediate and insistent inquiries as to causes and reasons for delay, when these occur, should invariably be made. Substantial benefits may be derived by offering to the men fair bonuses in case they secure a clean record of work done within the estimated time in the course of the week. This offering of bonuses removes the idea of "driving" which is so distasteful to many workmen.

Such a system, simple to the last degree, still is remarkably effective. Indeed, it is so effective because it contains, in simple form, the fundamental principles underlying all progressive methods of increasing shop efficiency, namely:—

(1) Determination of time in which work *should* be done.

(2) Placing it before the workmen themselves in definite form.

(3) Holding before them the chance for rewards in bonuses and promotion for record work, and the fear of reprimand or discharge in case of failure through carelessness, negligence, or laziness.

The question that immediately arises will be "Who sets the estimated time for the work and who checks up the actual time required?" I answer "The committee, as described in the February and March issues of this Magazine."

While the work of this committee will be varied, its functions many, still they will always relate to the one main object so ardently sought for—cheaper production costs.

Its members are vitally interested in the original cost of the tools and the rapidity with which they can be gotten through the tool room. These members are usually better qualified to estimate the length of time that should be required to build a tool of any description than any one man or group of men. After a short experience in estimating and checking up costs, they will soon become sufficiently expert to answer the purpose.

Method of Procedure.—After due consideration has been given to the tool model and the design of the tool itself, the estimate of cost of the tool should be determined and the record placed upon cards as noted. These cards should always be issued from and by this committee, so as to have the proper effect upon the workman. The card should travel with the work so that the workman may have a

constant reminder beside him as to the time in which this body of men expect the work to be completed—a constant reminder that any failure to live up to the estimate will be surely noted upon this card and an explanation required—that his failure makes an indelible record against him which will infallibly be seen by those in charge of the shop and commented upon to his disadvantage—that a poor excuse for his failure will only blacken his record still further—that, on the other hand, any betterment of the estimated record will be noted with satisfaction by these same men and will surely redound to his credit. A first-class honest workman will be pleased at the opportunity afforded him of placing an evidence of his superior ability upon records which are lasting and which are noted by those high in authority with a view to future promotions. The loafer and sluggard will soon be detected and can be sought out for improvement or discharge.

Owing to the fundamental importance of the work of this committee and the fact that upon it hangs most of the burden of bringing the shop to a condition of high efficiency, a short *résumé* of its functions, mentioned briefly in the March issue of THE ENGINEERING MAGAZINE, may well be brought out at this point.

An outline of its province would be somewhat as follows:—

1.—Planning a new designs of product to meet new market conditions in such a manner as to ensure

(a) Proper construction and accuracy of operation.

(b) A course of manufacture that will result in the lowest possible cost of production.

2.—Planning the re-design of an old product in the interest of economy of production.

3.—Devising and considering plans whereby the shop production efficiency may be raised to a high point.

This involves:—

(a) A close consideration of cost data so that the problem can be attacked at its most critical point.

(b) The devising of full sets of special tools so as to make possible the attainment of the desired end of lower manufacturing cost.

(c) The thorough consideration of these tools from the standpoint of design and *low production cost.*

(d) Investigation of existing manufacturing conditions in the shop, and the careful planning of methods through which a high state of manufacturing efficiency may be

A SHOP COMMITTEE "IN ACTION." THE FOLDING BLACKBOARD WHICH IS A FEATURE OF MR. CARPENTER'S SYSTEM IS SHOWN ON THE RIGHT.

reached. This itself involves a thorough knowledge of the types of machine tools best adapted to the work, and the best results that can be obtained from them through the use of modern high-speed steel for the cutting tools—a big subject in itself concerning which there is still a lack of definite data.

(e) The determination of "standard time" (or the time in which each job of work should be done) on each job in the shop by calculation and test. This work is of an importance that can aptly be termed critical. It is perhaps the most important work of the committee. As I will explain in detail later, I do not consider that the committee itself should attend to the tests and the determination of the standard times, but the head of the tool room should actively direct the work under the strict supervision of this committee. The work, especially at its inception, should be constantly considered by this body in order to ensure proper results.

The cut of a "committee in action" may add interest at this point. Note carefully the important model of a new invention on the table, which, together with the detail drawings and cost data, is being

thoroughly studied. In this case the new invention is receiving the careful, earnest consideration of these experts from every possible standpoint. The heads of important machining departments, the heads of the tool and designing departments, and the cost expert compose this committee. These men are considering this model from the standpoint of

(a) Design,
(b) Strength, ease and accuracy of operation,
(c) Ease of production and assembling of component parts,
(d) The most effective machining methods for quick, accurate and cheap production,
(e) The character and cost of tools best suited for the shop machinery and for the greatest economy in manufacture,
(f) The planning of machining operations for routine of manufacture for each part of the mechanism,
(g) The determination of the number of each piece that should be carried in stock and the most economical quantity to send through on each order,
(h) The approximate time required for each machining operation from the tools and the detailed preliminary estimate of cost.

A report covering these points, fully signed by each man, is sent to the manager, a copy to the designing and drafting department, and a copy to the head of the cost department, the committee of course keeping a copy for constant reference as the work on design, on tools, or on production progresses. Any necessary changes are considered by the committee for approval, and reports sent to proper parties. No change of any character will be for an instant tolerated unless it has the signed approval of the committee.

The folding blackboard (referred to in my article in February as an important adjunct to all committee meetings) will be seen to contain many notes referring to current work. As our men often say, "nothing gets away from that blamed blackboard." An order from the executive to consider and bring through to success any certain plan is placed upon the board and certain portions of the work are assigned to different men, these assignments being noted upon the board. *There each stays until it is accomplished.* I receive reports right "from the blackboard" showing progress made or lack of it. The character of the other reports of great importance sent directly to me by these committees has been fully treated in the preceding articles. The average manager needs no assurance as to the effectiveness of such a plan. It is a wonder worker.

TENDENCIES AND IMPROVEMENTS IN MARINE GAS-ENGINE CONSTRUCTION.

By Howard Greene.

The use of the combustion engine for marine propulsion is receiving increasing attention, and the broad principles involved were reviewed in our preceding issue. Mr. Greene's discussion is concerned with units of moderate size only, but brings out the most important points of recent progress in design and materials of construction. The assimilation to steam practice is specially interesting, and closely in line with the principles laid down in articles by Mr. Mathot, lately published in these pages.—The Editors.

LOOKING over the marine gas-motor field at the beginning of activities for 1907, one cannot fail to be impressed by the evidences of substantial progress that appear—not, perhaps, so much in the form of radical changes in individual cases as of a general tendency to adopt constructional forms and methods that have earned recognition as survivors of the process of eliminating the unfit, and to discard startling designs that possess no merit beyond the very doubtful one of distinct individuality.

The influence of the automobile motor, unquestionably harmful at first because of the extremes in light, high-speed, short-lived motors that followed its invasion of the sea, has almost disappeared, leaving, however, not a few important improvements such as *reasonable* weight reduction, the use of high-grade materials and the employment of high-class labor and manufacturing methods, refined and efficient carbureters and other fittings, and so on. But the day has passed when the automobile motor was transferred, with few changes, from the car to the boat, except in a few individual cases where extreme speed is sought; and manufacturers and users alike are opening their eyes to the fact that a motor will inevitably wear out faster if run at high speed than at a moderate rate—a fact that has persistently pushed itself forward notwithstanding all efforts to ignore it and to contradict the homely old saw about burning a candle at both ends. Extreme high speed and long life cannot be combined; no matter how slight wear may be, there is the inevitable argument that there would be still less if the speed were reduced. So we find that there is a prevailing preference for piston speeds that are quite moderate, and in some cases very slow, with the object of producing motors that will run and keep on running after the fashion of the

good old steam engine, which keeps on working until it becomes a relic of antiquity and is finally relegated to the scrap-heap, still able to turn its shaft. And it is not surprising to note that the marine steam engine—that most highly developed form of the world's greatest prime mover—is furnishing the model for a number of gas-engine details. For instance, the closed crank case in four-cycle motors is frequently discarded for the well-known steel-column cylinder support or an arrangement of A-frames, sheet-metal guards stopping the flying of oil; the reliability of the steam engine, and a fair degree of its flexibility, are goals that have been practically reached by the leading builders and are sought by all.

Radical departures from what may be called standard design are found in those engines in which there are more power impulses per revolution than in ordinary two-cycle or four-cycle motors having an equal number of cylinders. The objects sought are, of course, increased flexibility, smoother running, and high power in proportion to weight, resulting from the greater evenness of turning moment and the decrease in the proportion of idle strokes; the discarding of the flywheel, and the ability for self-starting also usually follow in a motor in which the shaft torque is practically constant. The Standard 300 horse-power marine motor has six cylinders and is double-acting—that is, explosions occur on both sides of each piston, the piston rods being carried through stuffing boxes in cylinder heads and into crossheads, the whole being similar, in a general way, to current marine steam-engine practice and very different from the ordinary open-ended cylinders and trunk pistons of the usual gas engine. Each cylinder is thus approximately equal to two ordinary four-cycle engine cylinders, or to one two-cycle cylinder, and the crank shaft receives six impulses each revolution. No flywheel is used. Steam-engine design is strongly suggested in many ways, such as the crosshead and connecting-rod arrangement, the bed plate, and the steel columns on which the cylinders are carried.

Much more ambitious, so far as constancy of torque is concerned, is the Rice double-acting two-cycle engine, in which there is an explosion twice every revolution in each cylinder, the explosions occurring on opposite sides of a single peculiarly constructed piston. The effect is thus the same as in an ordinary double-acting steam cylinder; but, like ordinary two-cycle motors, the Rice engine has no valves and no moving parts except the pistons, connecting rods, and crank shaft. There is no flywheel. The operation of the engine will be understood on reference to the accompanying diagram of two of the four cylinders. The long vertical cylinder is divided into three parts;

the upper explosion chamber, the lower explosion chamber and, between them, the pumping chamber, the latter being formed by enlarging the middle diameter and making it eccentric to the explosion chambers. The piston is shaped to fit these three parts, and the eccentric section acts as the pumping piston and at the same time carries a rod, projecting upward through a stuffing box, which transmits motion to the long connecting rod through a crosshead. The pumping chamber is in communication with the carbureter through the usual intake piping, not shown, and with the explosion chambers of the adjoining cylinder through transfer passages. When one piston is at the bottom of its stroke the other is at the top, the cranks being set at 180 degrees. In the diagram, piston B has finished its down stroke. Its upper end has uncovered the transfer port from the upper end of the pumping chamber of the adjoining cylinder and fresh gas is flowing in, while the exhaust is escaping through exhaust ports of the ordinary type, omitted from the diagram to avoid confusion. The upper end of piston A has compressed the charge received on the preceding stroke and is ready to explode it for the downward power stroke. Precisely the same conditions obtain in the other cylinder, B, though at opposite ends of the cylinder. This particular engine is experimental and differs in several details from the regular models now in course of construction. For instance, it will be noticed that two explosions occur simultaneously at opposite ends of adjoining cylinders. This is the result of the crossing of the transfer passages so that the pumping

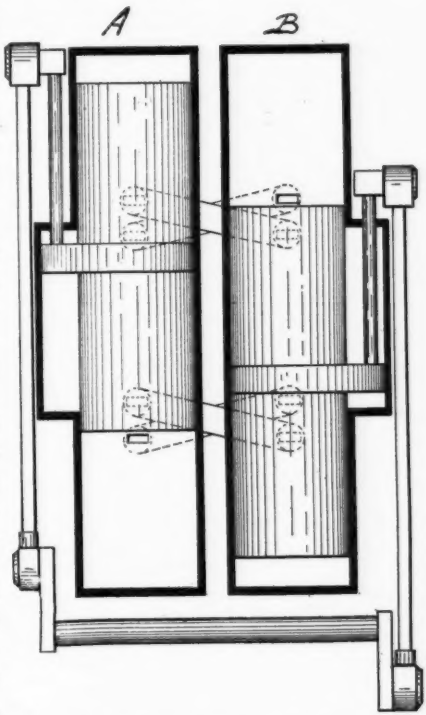
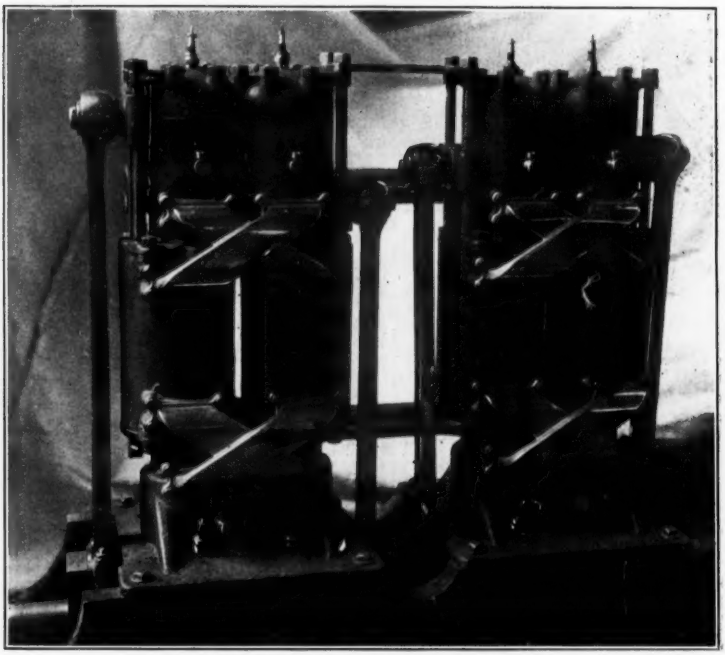


DIAGRAM SHOWING PRINCIPLE OF OPERATION, RICE TWO-CYCLE DOUBLE-ACTING ENGINE.



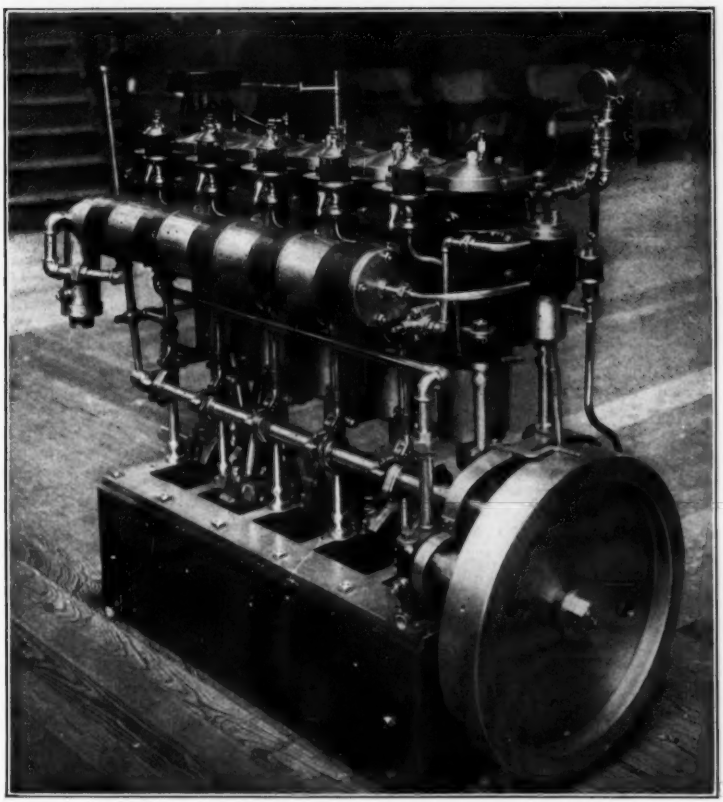
RICE TWO-CYLINDER DOUBLE-ACTING ENGINE.

Explosion chambers in both ends of cylinders. J. V. Rice, Jr., & Co., Bordentown, N. J.

chamber in one cylinder serves the explosion chambers of the other. In the new models each cylinder is a separate unit, the pumping chamber serving the explosion chambers in the same cylinder. The cranks of a four-cylinder engine can be set at 90 degrees and the shaft will receive an impulse every 45 degrees, or every quarter of a revolution. Six-cylinder motors are also being built, which will have twelve impulses per revolution, or one every 30 degrees. This form of construction avoids piston rods and stuffing boxes subjected to the heat of combustion; the ends of the cylinders are closed; connecting rods are long, and all working parts are exposed. Weight is kept down and the mechanical balance is good. The side thrust of the pistons, due to the method of transmitting motion to the connecting rods, is said by the manufacturers to be not more than 3½ to 4 pounds per square inch; the thrust of the ordinary trunk piston may be placed at from 12 to 15 pounds to the square inch. In the new models the height of the cylinders has been decreased about one-third. A number of these motors are to be installed in self-propelled railroad coaches

by a railroad company; the railroad engines will have six cylinders and develop 100 horse power.

While the more daring designers undertake the exploration of comparatively fresh fields, the majority conservatively confine their efforts to the improvement of existing designs. A striking example of this is the Dock four-cycle engine. This engine has five cylinders and the cranks are spaced 72 degrees apart; the stroke is very long, for a marine gas engine, being 8 inches, while the bore is 4½ inches. The four-stroke cycle is employed; the valves, symmetrically arranged on opposite sides of the cylinders, are all mechanically operated. The most interesting feature of the engine, however, is the self-starting device. At one end of the engine is a piston air pump,



DOCK FIVE-CYLINDER FOUR-CYCLE SELF-STARTING MOTOR.
N. Y. Safety Steam Power Co., Hope Valley, R. I.

PISTON, CONNECTING ROD AND CUP-AND-SOCKET JOINT OF DOCK ENGINE.

driven from one of the valve gears, which delivers air under pressure to a receiver placed in any convenient position near the engine. Only a small receiver is required, as the air pressure is called upon only to move the engine through a small part of a stroke. The starting is effected as follows: a valve is opened, permitting air to pass to the engine by way of the carbureter, where it takes up sufficient gasoline to form an explosive mixture. This mixture under pressure naturally passes into the cylinders whose inlet valves are open and whose pistons have therefore commenced the down stroke. These pistons are given an impulse by the compressed air, and the pistons in the other cylinders in which there are charges of combustible gas are forced up until the compression is completed and the point of ignition reached, when explosion takes place and the engine commences to run in the usual way. The cylinders to which the compressed carbureter air was admitted are of course filled with explosive charges of gas, and this gas is compressed and ignited in the regular order, there being no useless air to get rid of before a combustible charge can be admitted. This makes it possible to start the engine under load, an operation which is considerably simplified by the comparative constancy of the torque resulting from the use of five cylinders.

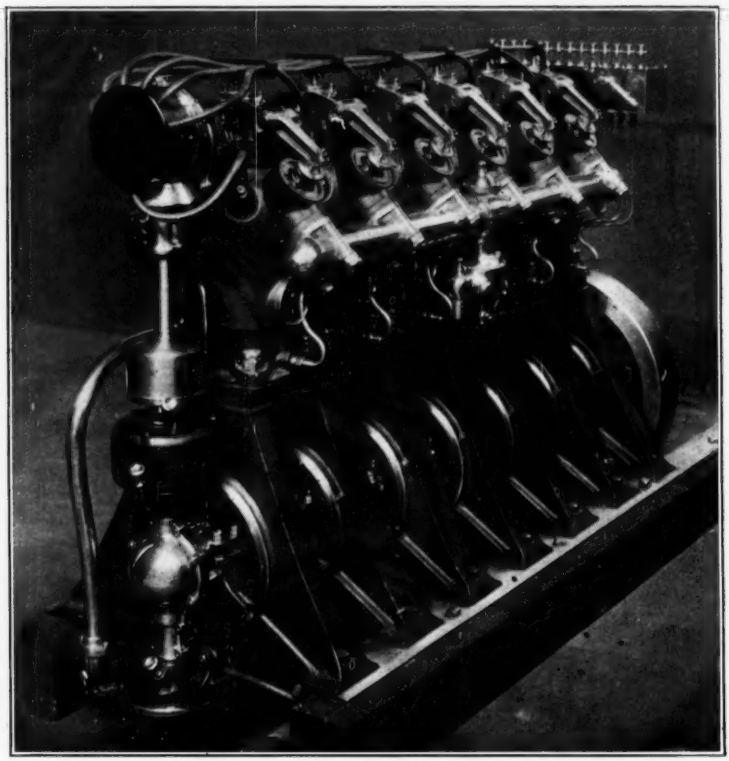
As there is nothing to hold the inlet valves on their seats except the compressed helical springs, they would, if closed, be lifted by the inrushing air of the self-starting device, if no preventive means were supplied, and the pressure, admitted to the pistons on the up-stroke, would counteract the downward pressure on the other pistons and so

prevent self-starting. So a very ingenious arrangement of the valves is adopted. The valve stem passes through and slides easily in a small piston fitted into the under side of the valve housing. A flange on the bottom of the little piston limits its upward movement, and it is normally held as high as it will go by the valve spring compressed between the usual key on the valve stem and the lower face of the little piston. When the engine is running the valve works in the usual way, the piston being inoperative. If, however, the valve happens to be closed when the starting device is brought into play, the compressed air, acting on the upper surface of the piston, forces it down and further compresses the spring, effectually preventing the lifting of the valve from its seat. The cam will lift the valve, however, regardless of the increased spring pressure, when the proper time arrives. A check valve in the pipe through which air is drawn while running is closed automatically by the pressure of the starting air, but opens as soon as this pressure falls to atmospheric.

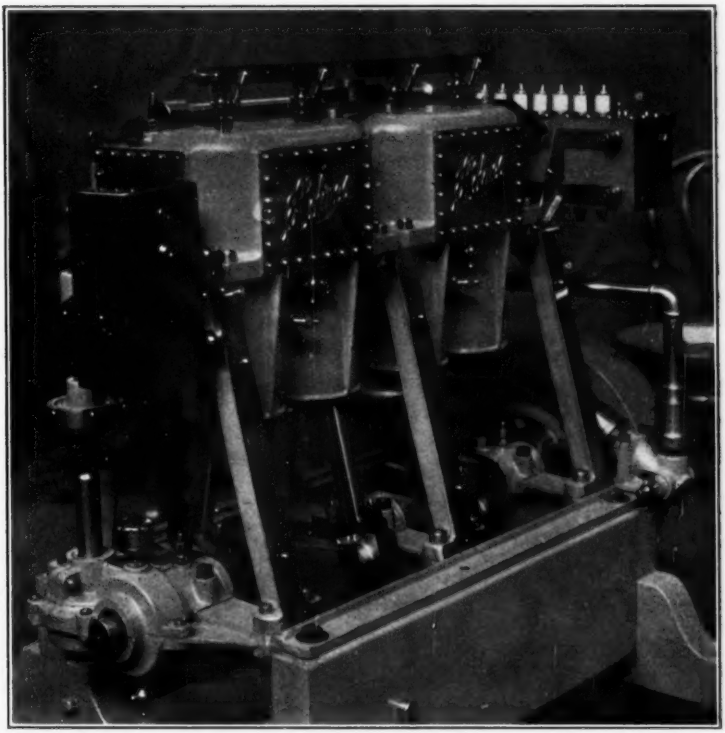
The connecting rods of the Dock engine are attached to the trunk pistons by means of cup joints instead of the usual wrist-pin arrangement. The upper end of the rod is enlarged and is hollowed to a cup shape, accurately spherical, and a corresponding projection on a diaphragm in the piston accurately fits into the cup. The outer surface of the cup on the rod is concentric with the inner surface, and a loose cup, made in halves, is placed over it and held in place by a screw collar. The collar is split at one side and a tapered screw is fitted to force the ends apart at the split and so, by friction, lock the collar firmly in place. This, of course, makes it a simple matter to take up all wear. The two principal advantages of this arrangement are that a very large bearing surface is provided, and that the piston is free to turn on its axis and equalize the wear on both piston and cylinder.

An engine that is typical of present tendencies in four-cycle marine practice is manufactured by the H. & H. Engine Company, in three sizes having cylinder dimensions of 4¾ by 5½, 6¾ by 7, and 8¾ by 8½, the maximum rated horse powers being 38, 77, and 160 horse power respectively. These ratings are based on a piston speed of 750 feet a minute. The three sizes are exactly alike in design, so that the photograph, which shows really the smallest engine, will illustrate the larger engines equally well. The practice of carrying all the valve gear above the cylinders is rapidly increasing in marine engines. In the engine referred to the cam shaft is carried in bearings bolted to the cylinder heads. The valves, all mechanically operated, are set into the cylinder heads with their stems at an

angle of 45 degrees from the vertical, and each is operated by its individual rocker arm pivoted to lugs cast on the iron boxes that at the same time form housings for the cams and carry the bronze bushings for the cam shaft. Cam thrust is taken by hardened steel rollers on the cam ends of the rocker arms. The cam shaft is rotated by bevel gears on a vertical shaft, bevel-gear driven from the end of the crank shaft. This vertical shaft extends below the crank shaft and carries at its lower extremity the centrifugal water pump; the pump is so placed that when the engine is installed in the boat it will be below the water line and therefore self-priming. On the vertical shaft between the two pairs of bevel gears is the generator which furnishes the current used for ignition when the motor is running. The six cylinders are carried by seven A-frames of cast



HURD & HAGGIN SIX-CYLINDER MARINE ENGINE, OVERHEAD VALVE GEAR.
Hurd & Haggin Engine Co., N. Y.

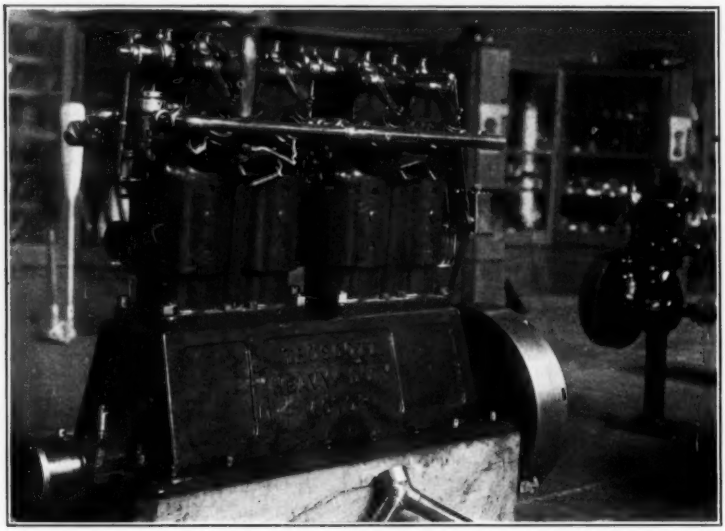


HOLMES LONG-STROKE LIGHT-WEIGHT MARINE MOTOR, CAST BRONZE FRAMES.
Holmes Motor Co., West Mystic, Conn.

steel; a large opening in each frame is bored out truly circular and the cast-steel brackets carrying the bronze split bearings are turned to a similar radius. This work is done with great care, so that when the parts are assembled they will go together in alignment, without requiring a long course of hand fitting. The lower parts of the bearing brackets are hollow, forming oil cellars, the oil being lifted to the shaft and bearing by oil rings of the usual type. The bases of the frames are bolted to longitudinal steel Z-bars of standard section.

A rather unusual combination of light weight and moderate piston speed is found in the motors built by the Holmes Motor Company. These are four-cycle motors with open bases and light cast-bronze frames supporting the cylinders, cast in pairs, which are carried down well below the point of support in the form of light tubes, a

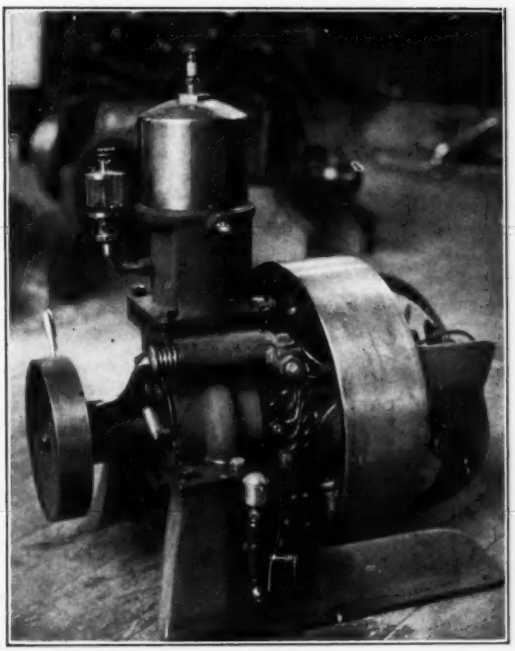
stiffening rib on each side running up to the integrally cast water jacket. The valves are all carried in housings cast on the sides of the cylinders, their stems extending downward, and the cam shaft is on a level with the lower ends of the cylinders, running in three bearings bolted to the A-frames. A vertical shaft and bevel gears drive the cam shaft and, extending upward, the vertical shaft carries the timer. The water jackets are formed by plates screwed to light frames cast on the cylinders. The builders of this engine have worked out the details with a view to the utmost accessibility, and tests have shown that two men can take the entire engine apart and put it together again in a trifle more than an hour. Engines of this type are being furnished by the Holmes Company to the United States Government.



HEAVY DUTY FOUR-CYCLE MOTOR, OVERHEAD CAM SHAFT DRIVEN BY ENCLOSED CHAIN.
Truscott Boat Manufacturing Co., St. Joseph, Mich.

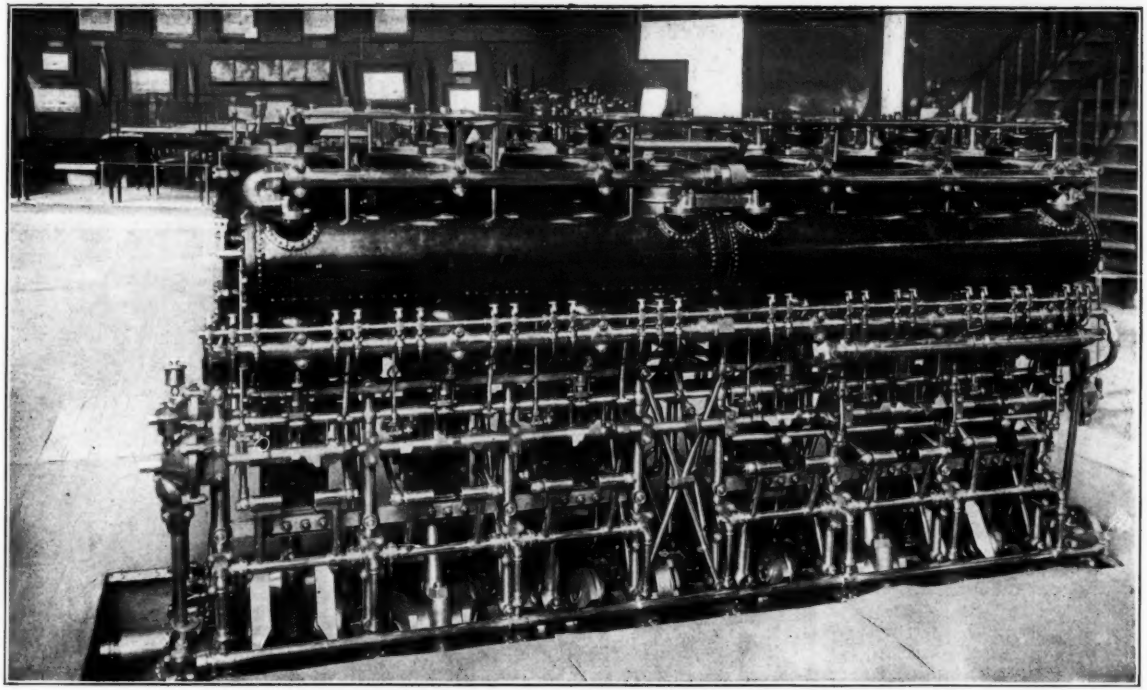
Another engine employing overhead valve gear is the new model four-cycle Truscott, but an unusual method of driving the cam shaft is adopted. Instead of a shaft with bevel gears, a chain is used, running from a sprocket on the crank shaft, between the after cylinder and the next one, to a sprocket having, of course, double the number of teeth, on the cam shaft. The cylinder casting is made with an integral housing for the chain to run in, and at the top both chain and sprocket are covered by a removable brass casing. The valves,

exhaust on one side and inlet on the other, are operated by rocker arms with steel rollers to relieve cam friction. Ignition is by make and break, the trips being actuated from eccentrics on the cam shaft; the time of ignition can be varied by giving the eccentrics more or less lead by means of a rod running through the cam shaft and rotating with relation to the cam shaft, carrying the cams with it, when moved longitudinally by a fork and collar arrangement controlled by a handle. Jump spark ignition can also be fitted. The same company has brought out an electric-lighting plant for yachts—or for that matter, for any purpose where a small plant is required—consisting of a two-cycle single-cylinder motor direct-connected to a direct-current generator with a capacity for feeding fifteen 16-candle-power 110-volt incandescent lamps. The floor space occupied is 18 by 22 inches and the weight 200 pounds. The field rotates about the armature and serves as a flywheel for the motor; a sensitive governor acts on the throttle, regulating the amount of gas taken into the cylinder at each stroke; or else the governor is adapted to act on the ignition, which is of the jump-spark type.



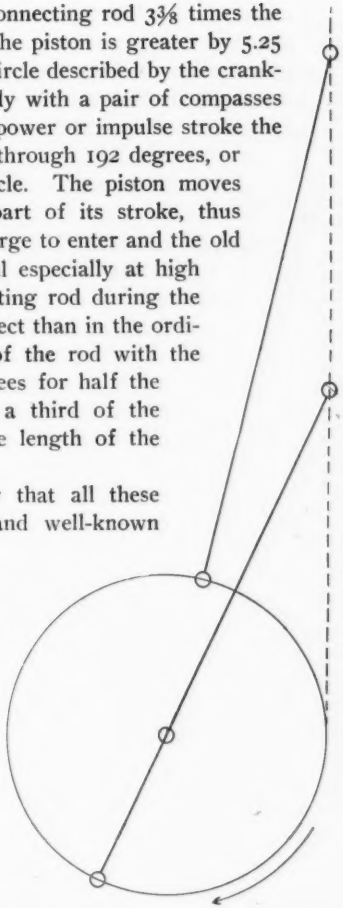
TRUSCOTT SELF-CONTAINED ELECTRIC-LIGHT SET.

Among other 1907 types may be mentioned an interesting little two-cycle motor, built by the Ramsay Manufacturing Company having the cylinder offset from the crank shaft a distance equal to the crank length, or half the stroke of the piston. In other words, the axis of the cylinder is tangent to the path of the crank-pin center.



STANDARD 300-HORSE-POWER GASOLINE MARINE ENGINE, FOUR-CYCLE DOUBLE-ACTING.
Water-cooled pistons and piston rods; started by compressed air. Standard Motor Construction Co., Jersey City, N. J.

The result of this is that with a connecting rod 3⅜ times the length of the crank the stroke of the piston is greater by 5.25 per cent than the diameter of the circle described by the crank-pin; this can be proved very readily with a pair of compasses and a diagram. Also, during the power or impulse stroke the crank pin is subjected to pressure through 192 degrees, or 12 degrees more than half a circle. The piston moves very slowly through the lower part of its stroke, thus giving ample time for the new charge to enter and the old charge to escape; this is beneficial especially at high speeds. The thrust of the connecting rod during the power stroke is of course more direct than in the ordinary type of engine; the angle of the rod with the piston is slightly less than 3 degrees for half the piston stroke, and 1 degree for a third of the stroke, with a rod four times the length of the crank.



AXIS OF CYLINDER, PATH OF CRANK PIN, AND POSITION OF CONNECTING ROD AT ENDS OF STROKE, RAMSAY OFFSET-CYLINDER MARINE ENGINE.

It is hardly necessary to say that all these features are more or less old and well-known to engineers; but their application to marine gas engines of the latest types is of no little interest—especially in view of the favorable results that have followed the use of these designs in actual service. It is a significant fact that most of the motors employed in self-propelled gasoline railroad coaches—of which a number are running and still more are contemplated or actually under construction—are of the marine type; and it is also interesting to note that the up-to-date gas motor has found its way into such exacting service as that of propelling life-boats, government inspection boats, and so on, proving, if proof be required, that the gas motor of today is a very different machine from the whimsical, unreliable affair of a few years ago.

COST REDUCTION THROUGH COST COMPARISON.

By C. E. Knoeppel.

Mr. Knoeppel's preceding article, in our March issue, discussed cost-comparison methods as applied to overhead burden and general expense. A concluding paper, next month, will outline the formation and working of a department of cost comparison.—THE EDITORS.

II. THE TREATMENT OF MACHINE, PART, GROUP, AND OPERATION COSTS.

IN the struggle for commercial supremacy, the desire and ambition of all who are at the heads of manufacturing enterprises is a maximum output at a minimum cost, and it is safe to say that much time and attention is given to the attempt to realize this ambition. At the present time, far-sighted managers are taking into consideration the fact that not only is labor from time to time seeking larger wages per day, but that the tendency of the raw-material markets is upward. They fully realize that unless these increases in their prime costs can be offset by either higher prices or an increased production, a reduction in the profits and dividends is sure to be the result. In many lines, competition is so severe as almost to eliminate the possibility of securing an increase in the prices, so that any equalization in profit must be brought about by a reduction in the costs, through an increase in the production. It will be found even in those cases where prices can be advanced that the desire is to secure an output costing as little as is consistent with good workmanship and material, so that in either case the end in view is "Cost Reduction."

In a preceding article, I endeavored to show how "burden costs" could be reduced; it is the purpose of this article to show how operation, part, group, and machine costs can be so compiled and classified as to facilitate comparison—the secret of cost reduction. It is true that in some cases excellent work has been done by shop managers along the lines of reducing shop costs, but maximum efficiency can not be secured unless the shop and office management work together. If a shop foreman could remember the time and money spent on each part or operation each day for the year he would be entirely independent of the office, in so far as the ability of the office to give him data regarding the efficiency of his men is concerned; but as this is im-

LIST OF MATERIAL. Sheet No

For John Smith and Company.

I- 18" x 24" Automatic Engine to run over @ 150.

Buffalo, N.Y.

Record Book Vol.....Page..... List Made Up II-2-6 By M SHOP ORDER 2441

Special Information.

ENGINE TO BE CAREFULLY TESTED BEFORE SHIPPING.

Order No.		NAME.	KIND OF MATERIAL	SYMBOL OF PIECE	NO. OF DRAWING.	NUMB. OF P'C'S	SUB ORDER	NOS.	WEIGHT OF ALL PIECES.	COST OF MATERIAL	COST OF LABOR	TOTAL COST.
							2441					
		Engine Bed	CI	A 404	2341	I	1					
		Fly Wheel	"	A 506	2343	I	2					
		Cylinder	"	D 43	2341	I	3					
	*	Cylinder Head	"	X 567	423	I	4	170	700#	18.90	3.86	5.75
		Engine Shaft	Frg	C 564	3442	I	5					
		Crank Shaft	"	C 565	"	I	6					
		Piston	CI	B 56	5667	I	7					
		Piston Rod	Frg	C 67	3442	I	8					

FORM A. LIST OF MATERIAL. THE FIRST RECORD FORM FOR A NEW ORDER. Thin white paper, 8½ by 10½ in. On this is listed every item going into the construction of the engine; on the sample above only a few items are entered by way of illustration.

possible he must depend upon a system devised to meet existing conditions.

The measure of a shop manager's ability is not merely the number of pounds of material shipped during a month. His ability to secure a maximum output might go unquestioned, but this maximum output might have cost the company a maximum amount of money. A shop manager in order to be classed as successful must secure a maximum

PRODUCTION ORDER. FINISHED / ROUGH

Production Order No	Piece No.	Drawing No.	Material.	To be Completed
2441.4	X 587	423	CI	
Date of Order.	**For Assembly Order No**			**Completed.**
11-2-6	John Smith and Company			11-3-6

Quantity.	Description
1	CYLINDER HEAD. $18.90 700# @ 2.70

NOTE:—Execute this order, returning same to factory office upon completion of the work. Charge all labor and material to the above Production Order Number.
When this Production Order covers the assembly of a machine, charge "labor" only to the Production Order Number.

W.B.C. Foreman.

FORM B. PRODUCTION ORDER. FACE.

A buff card 8 by 5 inches. Printed on both sides, the back being shown in the cut below.

Assembly				Boring				Turning				Forging				Milling				Planing				Drilling			
Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.
								11/3	30	9.5	2.31					11/3	48	3.0	60					11/3	20	2.5	.38

Threading				Grinding				Babbitting				Laying Out				Cutting off							
Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.
												11/3	51	2.0	.50								

Planing			
Date	Man No.	Hrs.	Amt.
		9.5	2.31
		3.0	.60
		2.5	.38
		2.0	.50
		17.0	3.94

FORM B. PRODUCTION ORDER. BACK.

output at a minimum cost. The office can lend valuable assistance, if the management will go to the necessary expense, by placing in the hands of the shop manager the means whereby minimum costs can be obtained—providing the shop management will not balk, as it often does, at the thought of attempting to use any "office" data to help them in reducing their costs. A proper organization and system—coöperation between shop and office managements—and the result will be a reduction in the costs of production.

Let us say that an order is received from John Smith and Co. for an engine. A "List of Material," Form A, is made out, every item that goes into the building of this engine being listed and given an order and sub-order number, although to illustrate this article only a few of the items have been shown. The shop is furnished with the necessary number of these lists and if it is necessary to machine any of the parts, a Production Order is made out as shown in Form B, which covers the "cylinder head", marked with an asterisk (*) on Form A. This order is made in duplicate, the original going to the department foreman while the duplicate remains on file in the office. The cylinder is drawn from stock on a written requisition and goes to the workmen

				PIECE NO. X 567*	
				JOB NO. 2441.4	
				WORKMAN'S NO. 30	
			C. B. CO., FORM NO. 9	NAME. Jamison	
ASSEMBLY	FORGING	DRILLING	GRINDING	CUTTING OFF	ALLOWANCE
BORING	MILLING	TAPPING	BABBITTING	FITTING	
TURNING ✓	PLANING	THREADING	LAYING OUT	TESTING	FOREMAN W.B.C.
QUANTITY 1	TOTAL TIME 9.5	RATE .25	COST 2.38		

JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1 2 3	4 5 6	7 8 9	10 11	12 13	14 15	16 17	18 19	20 21	22 23	24 25	26 27 28 29 30 31

FORM C. USED FOR REGISTERING TIME ON OPERATIONS.
Original is a thin buff card 5 by 3 in.

who are to machine this head. They use Form C, in conjunction with a time clock, for registering the time spent on the various operations, these cards being collected each day, checked against their pay-roll time, sorted by job numbers and posted to the reverse side of the Production Order as shown. When the job is finished, the various operations are totaled and posted to a permanent "Comparative Cost Sheet for Individual Parts"—Form D—the operations—"turning" and "milling" being shown on the line marked with an asterisk (*). The Production Order card can be then thrown away as it has performed its proper functions.

When the engine has been shipped, the cost keeper can take his office list and by going through his book of Comparative Cost Sheets can pick out the weights, hours, costs of materials and labor as shown

PAGE NO.

ARTICLE X 567.

ORDERED TO	ISSUED	COMPLETED	NO. OF PIECES	MATERIAL					TOTAL LABOR COST			
				KIND	WEIGHT	MEMO NO.	AMOUNT	WT. PER PIECE	NO. OF PCS.	NO. OF HRS.	RATE	AMOUNT
1941.6	8-1-6	8-2-6	1	C1	690	423	18 63	18 63	1	15		3 00
1950.3a	8-10-6	8-20-6	5	C1	3500	423	94 50	18 90	5	70		14 00
1930.62	9-4-6	9-8-6	3	C1	2100	423	56 70	18 90	3	9		1 70
2041.5	9-20-6	9-28-6	10	C1	6950	423	187 65	18 77	10	130		28 60
2441.4	11-2-6	11-3-6	1	C1	700	423	18 90	18 90	1	17		3 66

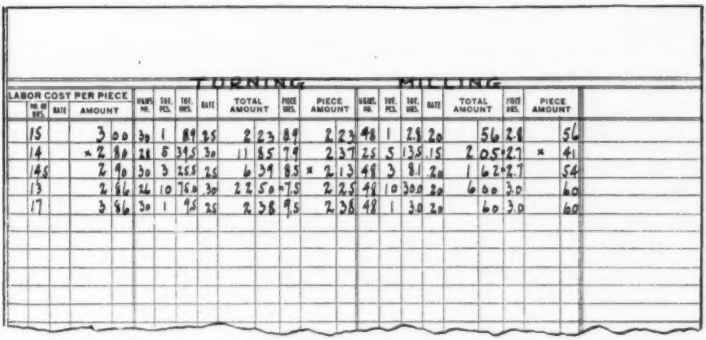
FORM D. COMPARATIVE COST SHEET FOR INDIVIDUAL PARTS. LEFT-HAND HALF. Original is a ruled sheet 16 by 14 in., printed alike on both sides and perforated on one margin for loose-leaf binding.

for the Cylinder Head on Form A. Totaling the various columns and computing the proper burdens on the basis of the productive hours will result in the total cost of the engine, which is posted to the Cost Statement, page 78, as shown. These total costs are then posted to the "Comparative Cost Sheet for Machines and Groups," Form G, page 79, on the line marked with an asterisk (*), so that we now have in black and white everything pertaining to the cost of every operation of every part as well as of the machine itself.

It would seem as if the amount of work necessary to secure and compile all this information is out of proportion to the benefits that might be derived. A perusal of the following, however, will show that the system is not as complex as one would imagine, especially if the possible results are kept in view. Machines are made up of groups, assembled and carried in stock, ready for final assembly with other groups along with perhaps many miscellaneous parts. These groups are in turn made up of parts, which with the miscellaneous parts must be machined, either in lots for stock or according to specification. This involves, in the majority of cases, several operations, so that the "operation" is really the basis—the scale being as follows:

Operations,
Parts,
Groups,
Machines.

If the cost of a complete machine is compared with a previous cost and is found excessive, the management will immediately want to know where the increase is, as well as what caused it; and unless a



LABOR COST PER PIECE																							
								TURNING								MILLING							
NO. OF DES.	RATE	AMOUNT			WKMN NO.	TOT. PCS.	TOT. HRS.	RATE	TOTAL AMOUNT		PIECE HRS.	PIECE AMOUNT			WKMN NO.	TOT. PCS.	TOT. HRS.	RATE	TOTAL AMOUNT		PIECE HRS.	PIECE AMOUNT	
15		3	00	30	1		89	35	2	23	89	2	23		48	1	28	20		56	28		56
14		× 2	80	28	5		345	30	11	85	79	2	37		25	5	135	15	2	05	27	×	41
145		2	90	30	3		255	25	6	39	85	× 2	13		49	3	81	20	1	62	27		54
13		2	66	24	10		166	30	22	50	75	2	25		48	10	300	20	6	00	30		60
17		3	66	30	1		95	25	2	38	95	2	38		48	1	30	20		60	30		60

FORM D, CONTINUED. RIGHT-HAND HALF.

The reproductions as given here show only the general column headings, the mode of ruling, and a number of specimen entries.

proper system has been introduced to take care of just such cases, it will be next to an impossibility to locate the trouble, especially if the machine is made up of a large number of parts, as is often the case. Without definite information the increase cannot be located because of the inability to tell whether groups, parts, or operations caused it. The word "the cost is too high" can be passed from the office to the superintendent, from him to his foremen, and from them to their assistants; but the poor assistants may know as much about what caused this high cost as they do about psychological research, so that no good is really accomplished.

The system as outlined is of value to the management when an excessive cost is located. We will say that the manager, in looking over the cost statement, Form F, finds that he made 19.4 per cent on the cost of this engine; but in looking at his Comparative Cost Sheet, Form G, he is surprised to find that the total cost was $74.50 higher than the cost of the engine previously built. He looks at the weight, the cost of the materials, perhaps at the specifications, and then concludes that the increase is too large to be passed by unnoticed, for he sees that it took the shops 70 hours longer to build this engine than it did the former engine. He takes his List of Material, and by checking back through the book of Comparative Cost Sheets for Individual Parts, Form D, with the cost keeper, he can locate exactly where the increases occurred. It may be that the cost of the bed, wheel and cylinder is in proportion to ones previously built, but when he comes to the cylinder head he notes that it cost in labor $3.86, which is the highest recorded; he finds, in looking across the sheet,

MACHINE: 1-18×24 AUTOMATIC ENGINE "OVER" @ 150 RPM.

SOLD TO: JOHN SMITH + Co. BY: W.A.L.

ADDRESS: BUFFALO, N.Y. SHIPPED TO: SAME

ORDER NO.	DATE SOLD.	DATE SHIPPED.	DATE OF INVOICE.
2441	10-28-6	11-24-6	11-24-6

ITEM.	PRICE.	COST.	GAIN.	LOSS
F	1450 00	1214 00	236 00	
		19.4% ON COST		
TOTAL.				
NET.				

FORM F. COST STATEMENT. FACE.
A green card 6 by 4 inches, printed on both sides. The back is shown below.

COST STATEMENT.

DESCRIPTION. 1-18×24 AUTOMATIC ENGINE

ITEM	TIME	VALUE	ITEM	AMOUNT	AMOUNT
MACHINING	400.0	100 00	COST OF MATERIAL	750 00	
ASSEMBLY	600.0	108 00	COST OF ALL LABOR	214 00	
			PRIME COST		964 00
BURDEN TOTAL	1000.0	208 00	SHOP BURDEN @ .10	100 00	
DRAWING ROOM	20.0	6 00	ADMINISTRATIVE BURDEN@.10	100 00	
PATTERN ROOM			COST TO MAKE		1164 00
			SELLING BURDEN @ .05	50 00	
GRAND TOTAL	1020.0	214 00	COST TO MAKE AND SELL		1214 00

SHIPPING WGT. 17590# ROUGH WGT. 20000# SHRINKAGE ..... PER CT.
COST PER POUND OF SHIPPING WGT. .067 ORDER NO. 2441.

FORM F. COST STATEMENT. BACK.

that workman No. 30 took 9.5 hours to turn the head, which for this piece is the longest time that has been turned in. By checking up each part and group the manager can tell with certainty whether the increase is a legitimate one or not, and while one may argue that there

MACHINE 18 x 24 AUT. ENGINE.

ORDER	MACHINING HRS	MACHINING AMT	ASSEMBLY HRS	ASSEMBLY AMT	D.R HRS	D.R AMT	P.S HRS	P.S AMT	TOTAL HRS	TOTAL AMT	SHOP	AD. EX.	SELLING	MATERIAL	TOTAL	WEIGHT	PER #
1600	380	76 00	590	90 00	20	6 50				172 50	91 00	97 00	49 50	760 00	1175 00	17400	.066
1820	375	75 00	520	78 00	12	3 00				156 00	81 50	89 50	44 75	753 00	1134 75	17500	.066
2030	370	74 00	560	84 00	15	5 50				163 50	93 00	93 00	46 50	743 50	1139 50	17450	.066
*2441	400	100 00	600	108 00	20	6 00				214 00	100 00	100 00	50 00	750 00	1214 00	17590	.067

FORM G. COMPARATIVE COST SHEET FOR MACHINES AND GROUPS.
Headings and rulings only. The original is about 11 in. wide and 9½ high.

is no use crying over spilled milk, I believe that there is such a thing as trying to prevent the recurrence of the accident.

The value of the method outlined, in enabling the management to locate increases and their causes, is not its only advantage; for unless the minor increases are brought to the attention of the shop management the costs cannot be reduced. It is a wise saying—"Look out for the small things and the larger things will take care of themselves," and it applies to costing as no other saying could. One of the most important parts of the system outlined is the bringing, automatically, to the attention of the shop foremen any increase in the costs of operations. The clerk in entering the order 2441.4 on his cost sheet (Form D, page 77), noticed that the turning took more time than on the record order—time being considered the basis. He accordingly made out a "Comparative Cost Report," Form H, as shown on page 81, sending it to the foreman, who investigated and found that No. 30 was at fault. In investigating, he necessarily spoke to the workman about the increase shown. Can anyone imagine that the words spoken to this man were in vain? Intelligent workmen desire to retain their positions and will be anxious to try and wipe out any increases. If, however, they do not care—and there are some workmen of this stamp—these little Comparative Cost Reports will weed them out in time.

Any system that will enable the shop manager to pass upon the efficiency of his men is a system that he as well as the management should welcome, as it embodies one of the essentials of cost reduction. Reference to Form D will show that No. 30, rate 25 cents per hour, has turned five cylinder heads X567 in lots of one, three, and one, the time for each one being 8.9, 8.5 and 9.5 hours respectively, while it will be noticed that two men at 30 cents an hour took this same job and turned the head in 7.9 and 7.5 hours, which is quite a reduction in time. It is true that the cost of one piece in lots of ten is less than the cost of one in lots of two or three, but it does not seem as if there should be an increase of two hours on the turning of job No. 2441.4 over No. 2041.5. At any rate, the record is clear enough to show the foreman that workman No. 30 should be spoken to, and that No. 26 is the man to put on work of this nature; for although the "piece amount" does not show a large reduction, the total cost has been reduced quite a little by this higher priced man as follows—

Job	Labor	Time	Burden
No. 2441.4	$2.38	9.5	2.38
No. 2041.5	2.25	7.5	1.88
Gain,	.13	2.0	.50

Total gain—63 cents, plus the two hours time.

I figure burden here on the productive hours as a basis, which is far more accurate than to use the productive value, inasmuch as a 25-cents per hour man uses as much of the power, heat, light, etc., as does a 10-cents per hour man.

A glance at the milling operation (Form D) will show that while No. 48, a 20-cents per hour man, did this work in about the same time for each piece, No. 25, a 15-cents per hour man, milled the work in 2.7 hours each on a lot of five as against 3.0 hours by No. 48 on a lot of ten, which shows that while No. 25 is a cheaper man, he is one that will stand coaching and right treatment.

Another point to consider is the value of the Comparative Cost Sheet—Form D—when new men are engaged, for the reason that in giving these new men work to do, the foreman can at the same time tell them the time it has taken to turn out the work in the past, and if a record is kept of the work of new men for a short time and compared with that turned out by former workmen, their efficiency or inefficiency can soon be determined.

A large number of concerns have under consideration the introduction of piece, premium, and other systems; and while it is not

COMPARATIVE COST REPORT.

Production Ord.	Piece No.	Drawing No.	Name.	Operation.
2441.4	X 567	423	CYL. HEAD	TURNING

W. B. C. FOREMAN 11-4-6 190

Note difference in cost of operation on above as compared with ~~Preceding~~ Record Order.

THIS ORDER.				PRODUCTION ORDER NO. 2041.5				INCREASE.		DECREASE.	
HRS.	MAN.	RATE.	AMOUNT.	HRS.	MAN.	RATE.	AMOUNT.	HOURS.	AMOUNT.	HOURS.	AMOUNT
9.5	30	25	2 31	7.5	26	30	2 25	2.0	13		

REASON OF INCREASE, IF ANY.
Fault of workman # 30

DATE 11-4-6 190 SIGNED W.B.C.

FORM E. COMPARATIVE COST REPORT.
Original is on white paper, 3 by 5 inches.

absolutely essential, it would be beneficial if some data were available which would give the time and costs of parts and operations. If the system described had been in operation any length of time and it was desired to install a premium system, it would be no difficult matter to select a few pieces at any time and by going through the cost book set "time limits" which would be more satisfactory to the management than approximations as to the time in which a piece should be completed; the effect on the workmen also would be about all that could be expected, for they could be made to realize that the time limits had been based upon past performances, and the better class of men would be satisfied in their own minds at least that it would be unfair to ask the company to set a limit on a piece or operation lower than the results obtained in the past.

It might be argued that in a large number of cases the costs could not be decreased to any appreciable extent, so that a system as outlined would be unnecessary. I will grant the first part of the argument, but not the second part; for we will suppose that a machine which we will call "X" costs $1,000 and sells for $1,200, while a competitor sells a machine patterned along exactly the same lines for $1,100. The manager has decided that his facilities for turning out the machine in question are as good as those of his competitor, so calls the shop management into consultation. If there were no detailed costs it would be impossible to know where to begin the investigation, so that the result of the consultation would be productive of little good.

But let us suppose that a system along the lines outlined has been in operation some little time. The List of Material is taken and each item checked with the Comparative Cost Book, and after a careful discussion it is decided that a reduction in the labor costs cannot be expected. It does not follow that this knowledge renders a reduction in the cost out of the question, for a study of the design of each part with the end in view of reducing the weights might be productive of some good. If, however, it is found that the weight of the machine cannot be lessened without impairing its efficiency, the question of better tools, improved jigs, and perhaps more efficient equipment could then be considered. Even if the investigation did not bring about the desired results—though it is very likely that it would—is there anyone who would argue that the investigation would not elicit information and suggestions from those interested, concerning labor costs of parts and operations, the design and weight of the parts, the question of better tools and jigs, which would be instrumental in reducing costs along other lines?

It may be well to explain that the time necessary to secure and compile the information pertaining to the product is not as great as one would suppose, especially if the system has been carefully devised to meet the existing conditions and the clerks each day record all the data secured the previous day. The main requirements are a harmonious organization—all working for the best interests of the company—and a time-keeping system that can be depended upon. If these are to be had, the cost of the securing, recording, compiling and investigating the data will be more than offset by an increase in the production in the same number of productive hours, which means—"Cost Reduction."

PRESENT PRACTICE IN THE USE OF SUPERHEATED STEAM.

By Reginald Pelham Bolton.

II.

In a preceding article Mr. Bolton reviewed the early troubles experienced in the use of superheat, the most important recent tests and experiments (American and Continental), and the general relations of superheating to economy in the steam cylinder. A concluding paper will take up locomotive and marine practice and will present also a bibliography of the literature of the subject.—THE EDITORS.

IT is a not infrequent matter of comment by enthusiastic European advocates of high-temperature superheat, that general American engineering opinion seems to have settled into a position adverse to their view.

They point, and with justice, to the remarkable results achieved by the use of superheat of from 400 degrees to 700 degrees F., so well recognized in Europe that manufacturers of engines specially designed to operate with those high temperatures feel safe in guaranteeing effective results of an extraordinarily economic character. Steam engines of various classes are readily procurable under guarantees of operation affording an effective horse power for the following steam consumption, with added heat of 500 degrees to 600 degrees:

Single Non-Condensing,	15.5 lb.
Single-Cylinder Condensing,	13 lb.
Compound Condensing,	10 lb.
Triple Condensing,	8.75 lb.

while American manufacturers are declining to contemplate the construction of machines for such high temperatures. There is, however, much to be said in favor of this point of view, which is by no means wholly American.

The prime cost of such high-class machines, their special character and comparative delicacy of mechanism, are features which may, and, no doubt, do discount by fixed charges, for interest, depreciation, repairs, and high-class labor, much of the refinement of economy resulting from their use, I prefer, however, to regard the reluctance of American manufacturers in this direction as being based on the very practical view, that the generation of such high temperatures in the superheater is liable to difficulties and objections in operation due to the necessarily accompanying high temperature of gases, and to

the considerable fluctuations liable to be met with; and it is certain in the present state of the art of the addition of superheat to steam, that much remains to be learned and accomplished in these directions.

A trial by M. Marechal of Rouen showed that an economy *in fuel* established by superheat at 536 degrees F. was not increased or bettered, in the same engine and boiler combination, by an increase to 650 degrees F.

At the Annual Congress of the Associations of Steam Apparatus Manufacturers in 1894, Marechal gave an economy of 16.5 per cent in *coal* for a saving of 22.3 per cent in steam, with steam superheated 536 degrees F. Later, Marechal tried again at 650 degrees F. and found he did not reduce the coal. But the engine may have responded and probably did respond to the increase in superheat, as shown in the successive trials of steam turbines reported by Hodgkinson, but it was the flue-gas and superheater combination which was at its limit of economy at the lower figure.

M. Dejace of Brussels gave an economy of 6.2 per cent in *coal* for a saving of 16.4 per cent in steam, with steam superheated 473 degrees F.

Such effects may be due not only to flue-gas conditions, but to the fluctuating extent of added-heat; and in both we may feel that a proper conservatism has awaited development which shall place the superheater in a more definitely desirable and controllable condition. That these conservative considerations are not confined to American engineers is evident by a perusal of the opinions of some of the eminent French and German engineers who have specially studied the subject. Vanderstegen admits that:

> "It cannot be said in a general manner, that superheat is always to be applied, or at what temperature, or that it should be systematically prescribed.
>
> "In large installations, such as central stations, where the special object is the reduction to a minimum of the cost of the kilowatt, superheat is demanded.
>
> "On the contrary, when the machine is of small importance, or where its work is very variable, or where it operates in an irregular manner, and above all, if the operating staff has not the necessary competence, it is evident that very often the economy to be secured may not outweigh the complication of the installation."

M. Ch. Compère, whose valuable summarization of experiments and data for the Société des Ingenieurs Civils has been already referred to, concludes his observations with the remark that, "with well-considered applications, superheat will enable the steam engine to compete with the gas engine, but it must not be overlooked that the addition of superheating apparatus adds a complication to the installation"; and he, therefore, insists upon "the necessity of studying

each installation in all its parts, boiler, engine, superheating, and piping."

A practicable limitation of the desirable extent of superheat has been found to exist in the temperature of the exhaust. Experiments on existing conditions of turbine and condenser, in which the heat conditions have been varied by an addition of heat to the steam supply, have shown remarkable results in gain of economy, due to the fact that, by reduction of cylinder losses, the total weight of steam was largely reduced; and the total heat, therefore, emitted to the condenser became less than that with which its proportions and the extent of its cooling medium were designed to deal; consequently, it produced superior results in the reduction of pressure and showed large accessions by "increased vacuum."

But such relative gains must not be taken to afford a measure of the value of superheat or they will lead to disappointment. A due proportion between added heat, cylinder conditions, and condenser proportions, is the combination to which the designer of such machinery is necessarily led, and here again the value of the subject of superheat is demonstrated, in directing the attention of engine designers and machinery owners to the consideration of condenser details and conditions, an element in the combination of power production commonly treated with almost as much disrespect and callousness as that of fuel.

In this respect then, we may also feel that a step has been made, a distance marked off, and a fresh incentive indicated, by the past ten years; and it may be added that while much of the work in this direction is due to English marine practice, American engineers, in the development of power-station practice, have taken no inconspicuous part.

Heating Buildings.

As a heating engineer, I could not pass from this subject without touching upon its bearing on the matter of interior heating, which, on account of climatic conditions, so vitally affects American steam-engine practice. Questions have been put to me on increasingly numerous occasions during recent years, as to what benefit can be expected from the combination of superheat in steam apparatus, the major use of which is to operate—as reducing valves—for the supply of exhausted steam into heating systems. There are many cases, for instance, where the supply of exhausted steam is not sufficient for the work of heating, and common practice, then, introduces into the system a supplemental supply of live steam, reduced in pressure through a reducing valve, and by this process, of course, more or less super-

heated. Practical operation, confirming the known theory of the subject, has shown that such superheated supply does less effective work in heat-radiation than the saturated exhaust, and it has frequently involved a loss of economy in results. How, then, shall a steam supply still further initially heated afford satisfactory results? The subject is one involving consideration of each separate set of conditions, but, broadly speaking, there appear to be the following directions in which advantage may exist, provided the combined apparatus be harmoniously designed and proportioned.

An addition of superheat is of advantage, if carried so far as the point at which radiation is desired but no further, at which point saturation should be designed to supervene.

Advantage may then result from the absence of moisture in mains and branch piping. Supply pipes for high-pressure superheated-steam supply may be of smaller size than those for saturated steam, the accepted sizes of which have been affected by the presence and propulsion of moisture.

But I can see no reason why heating practice should lag behind the development of steam-power production. While existing heating appliances have all been developed from practice with the use of fully saturated vapor, it seems not unreasonable to expect that the wider demand for the use of superheated steam, due to economies effected by its use prior to its exhaust into the heating systems, will force upon designers of the latter apparatus modifications which will advantageously utilize vapors at higher temperature and in dry condition. Such improvement would appear to lie in the direction of a great reduction of annular or interior spaces in radiating apparatus, the interposition of a less depth of vapor between the surfaces of dissipation of heat, and also of the production of a more active circulation of the heating vapor over the dissipating surfaces.

If this course be followed, the next few years should see American steam and heating practices fully in accord. The importance of the latter part of engineering work in the United States is undeniable, inasmuch as American practice, systems, and appliances for heating are now generally accepted by the rest of the engineering world.

Steam Piping.

The introduction of superheat into existing piping, planned and proportioned to provide for saturated steam, introduces a considerable risk on account of the increased degree of expansion. Such piping, also, will be found to be undesirably large, and may thus in part defeat the object of the added heat. Since the rate of travel of the ad-heated gas should, as practice has generally demonstrated, be greater than

practice has established for low-temperature steam, speeds up to as high a rate as 20,000 feet per minute may be found practically economical, the loss in pressure due to such rate being compensated for by the conservation of superheat. The commonly accepted proportions and arrangement of pipes must, therefore, be considered as subject to considerable modification in future, and yet the precautions of standard methods in providing for drainage of pipe runs are quite as necessary, since the high velocities introduced are liable to produce peculiarly severe water hammer if any condensation should be present in opening up a pipe to the supply.

The growing tendency to adopt high working pressures has already brought out a supply of methods of jointing, materials for packing, improved forms of pipe anchorages, and expansion joints, which are adapted to the purposes of high temperatures. Much more care will be necessary in the selection of materials and in the design of piping and accessories.

George Hutchinson, in Transactions American Society Mechanical Engineers, Vol. XXIV, points out that if superheated steam be introduced into a pipe system designed for saturated steam, there will be a diminished difference of pressure between the two ends of the line on account of the lower density of the superheated vapor and its freedom from moisture; and the same conditions will also cause a reduction in friction.

In large pipes, of course, the beneficial effect is increased by reduction of radiation, and with small pipes, the gain is chiefly produced by reduction of throttling. In the latter case, a speed of 100 feet per second with superheated steam will correspond approximately to the friction, or throttling loss, of saturated steam at 60 feet per second. The combination of high speed and extra covering is to be aimed at in proportioning any piping for superheated vapor; under best circumstances, the loss by friction may be no greater than with saturated vapor, and the radiating loss equivalent to a degree F. for each 6 feet of pipe.

Joints.

The introduction of such high temperatures in piping has caused much difficulty on account of the failure of joints, packing, and expansion arrangements. The trend of up-to-date work in this line is towards the use of extra heavy piping, flanged joints of specially secure character, metallic packing or jointing material, and provision for expansion by the spring of bent or curved tubing.

Forged flanges are now made in standard sizes, and are connected to the pipe in a number of ways, by shrinking, rolling, threading, or

by "peaning" the end of the pipe over the flange. The face, in all high-class work, whether of the flange or of the "peaned" tube, is turned, making a true face for contact with the metallic gasket. Spring bends are also made in standard forms and sizes, the capability of extension and contraction of which is ascertainable.

Pipe covering must be more complete and, therefore, more expensive. An example reported by Prof. Jacobus at Melbourne Mills, Minnesota, may be quoted: a pipe of 6 inches diameter carried a covering of an outside diameter of 12½ inches; the covering was composed of 1⅛-inch asbestos felt, and outside of this covering was a layer of carbonate of magnesia, held by wire, and plastered over with asbestos cement.

Water-Works Engines.

This class of engine has been developed to an extremely high degree of efficiency and excellence, and in it, therefore, the advantage to be gained by the addition of superheat is relatively the least, and comparatively small increase in economy is to be anticipated. Pumping engines showing mechanical efficiency as high as 96 per cent are in operation, in which refinements in construction and in re-heater and feed-water heater combinations, have resulted in duties as high as 178 million foot-pounds per 1,000 pounds of coal burned, steam consumption as low as 10.32 pounds per indicated horse-power hour, and a coal consumption of 1 pound per indicated horse-power hour. Nevertheless the addition of superheat is capable of producing some benefit even in such extraordinarily economical combinations, as will be seen from the following example. The results show a progressive increase in duty following progressive increase in superheat. Practically similar conditions of vacuum and of pumping head were observed.

Tests of Worthington High-Duty Pumping Engines, at the Central Park Station, Chicago.

Reported in the Engineering News, of May, 26, 1904.

Steam Pressure	141	142	147	145	144
Superheat, F.,	63.4	71.2	87.2	142	154
Duty per 1,000 lb. steam	156,602,731	157,133,021	161,676,942	163,104,857	174,735,801

Relation to Coal Consumption.

Fuel.	Maryland and Juniper.	Pocahontas.	Maryland.	Maryland.	Maryland.
Calorific value,	13,500	14,260	14,191	13,531	14,213
Duty per 100 lb. Coal,	137,502,733	150,592,270	149,067,802	132,607,122	150,971,958

These results show that the fine performance of the engine had been to a great degree neutralized at the furnace.

The No. 10 pumping engine in the St. Louis water works reached a duty, with dry saturated steam, and only 126-pounds pressure, of 179,454,250 foot-pounds per 1,000 pounds of steam, and it will be seen, therefore, that very close study and careful arrangements will be needed to improve the work of such wonderful machines by mere addition of heat to their working supply.

Turbines.

In the development of the turbine during the past decade, superheated steam has played a most important part. The feature pointed out by Professor Thurston, in his last paper before the American Society of Mechanical Engineers, namely, the peculiarly undesirable effects at turbine speeds and under turbine conditions, of the presence of moisture in steam, has been conclusively demonstrated and has led to the settled conjunction of superheat with turbine operation.

Numerous demonstrations have been made of the beneficial effect of superheat in such apparatus, which are really demonstrations of the injurious effect of the presence of moisture. The resultant economy has been shown to be practically constant under considerable variations of load. A series of tests on the Parsons type, reported by Mr. Francis Hodgkinson in 1904, demonstrated the foregoing so very clearly as to be worth re-presentation.

Speed of 1,800 revolutions per minute, Same machine throughout.

A. Non-Condensing.

Without Superheat.

Pressure.	Load.	Lb. of steam per Brake Horse power hour.
140 lb.	99 per cent.	28.26
	With Superheat, 100° Fahr.	
155.5 lb.	36 per cent.	30.33
153.5 lb.	70 per cent.	24.06
149.4 lb.	142 per cent.	23.46

B. Condensing, 28 inch Vacuum.

Without Superheat.

151.9 lb.	19 per cent.	19.89
151 lb.	52 per cent.	15.52
149.8 lb.	74 per cent.	14.49
149.5 lb	102 per cent.	13.77

With Superheat, 100 degrees F.

Pressure.	Load.	Lb. of steam per brake horse power hour.
154.7 lb.	32 per cent.	15.32
150.8 lb.	65 per cent.	13.27
151.4 lb.	103 per cent.	12.38
150.9 lb.	143 per cent.	12.99
150.1 lb.	198 per cent.	13.91

Another test, or rather series of tests, on a 1,000 horse-power turbine, with 150-pounds pressure, 1,800 revolutions, gave:

Non-Condensing. Full load.

Saturated Steam	28.1 lb. per brake horse power hour.
Superheat, 100 degrees F.	23 lb. per brake horse power hour.

Condensing. 28 inch Vacuum.

Saturated steam,	14 lb. per brake horse power hour.
Super-heat, 100 degree F.	12.4 lb. per brake horse power hour.

Other tests on machines of similar proportions gave, with different degrees of vacuum:

Saturated Steam. 26 inches Vacuum, 1,800 revolutions.

Pressure.	Load.	Lb. of steam per brake horse power hour.
155 lb.	48 per cent.	18.35
154 lb.	71 per cent.	16.62
152 lb.	103 per cent.	15.06
152.5 lb.	141 per cent.	14.7

Superheat, 150 degrees F. 26 nches Vacuum. 1,800 Revolutions.

Pressure.	Load.	Lb. of steam per brake horse power hour.
152.5 lb.	48 per cent.	16.
150.7 lb.	92 per cent.	13.18
148.7 lb.	118 per cent.	13.
145 lb.	141 per cent.	12.98

Saturated steam. 28 inches Vacuum. 1,800 revolutions.

155 lb.	48 per cent.	15.95
151.5 lb.	72 per cent.	14.65
151.5 lb.	102 per cent.	13.76
152 lb.	143 per cent.	13.99

Superheat, 150 degrees F. 28 inches Vacuum. 1.800 revolutions.

151.4 lb.	48 per cent.	13.85
148.6 lb.	98 per cent.	11.79
149.9 lb.	124 per cent.	11.42
149.2 lb.	141 per cent.	11.5

Trans. Am. Soc. C. E., Vol. LIV., 1904.

A test on Curtis turbines, reported in Transactions of the Engineers Club, Philadelphia, 1904, gave these results:

Kilowatts.			Steam per indicated horse power hour
600	140 lb.	saturated steam	12.2 lb.
600	140 lb.	superheat, 150 degrees, F.	10.68 lb.
2,000	156 lb.	superheat, 212 degrees, F.	9.76 lb.

We may conclude therefore that under all conditions of operation, whether condensing or non-condensing, and under extreme divergences of load, the addition of heat to the steam in the turbine engine has demonstrated its desirability, and may be taken as an element of standard practice which will keep pace with the development of steam-turbine installations. Inversely, it is to a great extent true that the turbine owes its advance in favor to the settled character of this feature of its installation.

RARE METALS AND MINERALS AND THEIR USES.

By E. Schaaf-Regelman.

The development of special alloy steels and extensive investigations on metallic-filament incandescent lamps have produced, within the past few years, a considerable demand for the rarer metals. The details of the economic applications of these materials are a matter of common knowledge, but little is generally known of the minerals and sources from which the metal supply is drawn. Mr. Schaaf-Regelman's paper presents interesting information on these questions, of which his position as a specialist in rare metals and minerals gives him an authoritative knowledge.—THE EDITORS.

IT is not more than a few years since the so-called "rare minerals" first attracted attention outside of the scientific world, but within a very short period this branch of the mining industry has become of such importance to many metallurgical and chemical industries that a study of the great progress made in this line and the conditions of supply and demand is very timely.

The strongest impetus for the search of many of the ores containing rare metals has come from the steel industry and its allied metallurgical branches, and the alloying of steel with other metals is, in the opinion of many, the most conspicuous proof of the ardent desire of our engineers for progress and improvement. In the oldest times tools and weapons were made of stone, later on of copper, brass and other metals and alloys, which we consider soft today; finally iron was used, and our fathers and grandfathers converted this into steel; but even the best qualities of steel are inadequate for our modern working methods, and especially our high-speed tool-machines require a more resisting and durable material for their cutting, milling, fraising, planing and boring tools than the best tempered steel will enable us to produce.

Manganese, nickel, and chrome alloys of steel are those used most extensively, but less for tools than for other purposes, and these metals cannot be classified as rare and are therefore not considered here.

TUNGSTEN, or Wolfram, as it is sometimes called, although unknown to many a man, is on the verge of turning from a rare into a common metal, as its regular production on a large scale is now an assured fact. While the whole world's production of tungsten-ore concentrates during the year 1900 amounted to only about 150 tons, of which the United States furnished about 40 tons, there were 3,500

tons produced during the year 1905, with about half of this quantity coming from Australia, about 820 tons to the credit of the United States, and the rest from several European localities, each of but little importance. At least 80 per cent of the American production come from the State of Colorado, and as the deposits in that State are extensive and easily accessible, the output could at least have been doubled during recent years, had it not been that competing interests were fighting for the supremacy in this field. A large proportion of the American production has therefore been exported and sold to European consumers, while several American makers of tungsten compounds were obliged to buy Australian ores in order to keep their works going and to supply the constantly increasing domestic demand.

The chief use of tungsten is in the manufacture of tungsten steel, and this again is mostly used for high-speed tools, magnet steels, and in European countries also for armor plates and projectiles. The percentage of tungsten in tool steels varies greatly, according to the special use for which they are intended, but tungsten always imparts to the steel the property of self-hardening in the air after forging without necessitating any of the usual methods of tempering.

It is unquestionable that the United States leads in the manufacture of tool machinery, and consequently the demand for tungsten steel is so large that considerable quantities of ferro-tungsten and tungsten metal have to be imported; but it is gratifying to an American to note the decrease of these imports and the increase of domestic manufacture and, as strong and intelligent interests have taken hold of the situation in Colorado recently, it is to be hoped that the mining end of the business also will henceforth be developed more satisfactorily and make American manufacturers independent of the vagaries of a very erratic ore market.

MOLYBDENUM, which, in spite of the widespread attention it has received of late, still preserves all the characteristics of a rare metal and will undoubtedly remain "rare" for some time to come, is largely used for the same purposes as tungsten; but in addition thereto it enjoys many and varied applications in the chemical and ceramic industries, but the quantities used in others than the metallurgical line are but small. Although it is authoritatively stated that the action of molybdenum in the steel is from two to three times as powerful as that of tungsten, technical difficulties have opposed themselves to the production of pure compounds at low costs; but as soon as a constant and reliable supply of the raw material shall be insured, these difficulties will certainly be overcome. Molybdenum

will then have a much wider range of application, inasmuch as it is already now used advantageously for improving the steel for rifle barrels, for large guns, for propeller-shaft forgings, and also for wire drawing, as, if a certain proportion is added to the steel, this increases its elongation considerably and improves its flexibility. Moreover, the manufacture of molybdenum steel is less complicated than that of tungsten steel, and as soon as a regular production of molybdenum ores can be relied upon this metal will become of very great importance.

Australia is again the chief producer of the ores containing molybdenum, and last year's output is estimated at about 70 tons. While the American continent, especially the eastern part of Canada, produced nearly the same tonnage, this ore is of much lower percentage and consequntly of smaller yield, but Canadians are slow to adopt modern machinery and improved methods for the treatment of these ores, while Colorado will within a short time have a plant especially designed for concentrating them and it is very likely that this State will soon outclass Canada, as the ore bodies are plentiful but of no commercial value without the proper treatment.

VANADIUM and URANIUM are nearly always named together as almost all ores containing one metal also contain the other. Uranium, however, is used very little for steel-hardening purposes outside of the well-known German steel foundry and gun factory of Krupp at Essen, where the use of uranium has apparently passed out of the experimental stage but where the knowledge of its application is guarded most jealously. Vanadium, on the other hand, has been used in France and Sweden for many years for increasing the tensile strength and toughness of steel, but its high price has prohibited its application on a large scale. The French and German armor-plate works use an alloy of vanadium and nickel and obtain excellent results and the superiority of French automobiles is said to be due to the liberal application of vanadium steel in their construction. Although vanadium alloys have been offered in the United States extensively for quite some time it has not been possible to awaken a general interest among American steel manufacturers, but developments are watched eagerly now as one firm has recently started the treatment of the Colorado vanadium ores on a comparatively large scale, and ferro-vanadium is to be manufactured in the Pittsburg district and marketed at a lower price than the imported material has been offered at so far.

Uranium has been detected in more than a dozen different min-

erals, which are found in nearly all mountainous countries of the globe, but the percentage of the uranium is generally too small to warrant extraction, and workable deposits of uranium minerals are limited. Since the discovery of radium these uranium minerals have become of special interest, as the percentage of uranium is in direct proportion to the radio-activity of the mineral, and all other applications of uranium metal and uranium salts, which latter are used to some extent as color on porcelain and glass, are overshadowed by the importance of uranium as the chief source of radium.

TITANIUM is unique among the metals used for steel alloying purposes, as the raw material, i. e., ore containing titanium, is most abundant; but the metal and its alloys are distinctly rare, and while it is known that titanium imparts to the steel most valuable properties, its application is still in its infancy, because the technical difficulties in an economic production on a large scale have not been overcome as yet.

An ore called Rutile with a high percentage of titanium is mined in the southern States, but its principal use is as a pigment in the ceramic industry, as it has been found difficult to alloy high-grade titanium material with steel in the ordinary way. The perfection of the electric furnace has been a marked progress, however, and the great amount of experimental work now being done in this direction aims at the utilization of the vast ore bodies of titaniferous iron ores found on both Western and Eastern Continents, and the production of steel with varying contents of titanium directly from the ore. The principal advantage of the presence of titanium in steel is that it increases the density of the material and particularly its transverse strength, thus giving a harder chill and better wearing quality. It is claimed, therefore, that titanium steel will be the coming material for car wheels and axles and its application to rolling and crushing machinery will also be very extensive.

It is noteworthy that the best results are obtained in many cases by alloying not only one of the above named rare metals with steel, but by compounding them with nickel or chromium, and tungsten-chromium-steel, tungsten-nickel-steel, molybdenum-chromium-steel, and other similar combinations are the result. They have many distinct features different from an alloy of one of these metals with steel. Variations in the proportion of each constituent very often produce surprising effects, and metallurgical and chemical engineers have a wide and varied field of investigation and research before them.

Even so short a treatise on the subject as the present one should not fail to mention the pioneer work done by the alumino-thermic process in the manufacture of rare metals of exceptional purity, but their high price has materially restricted their application.

Europe has so far led in the manufacture of these metals and alloys, and large quantities of ores, carrying such metals, have been exported from America to Germany, France, and England and the finished metals and alloys have been re-imported. While there are in the United States a small number of plants devoted to the manufacture of these special alloys, their output is far too small to satisfy the rapidly increasing demand, and the main drawback to an adequate growth of this industry has been the lack of thoroughly trained chemists and metallurgists. With her gigantic steel industry, her unrivaled machinery manufacture, her abundant supply of raw materials, and the strong desire for higher efficiency in every branch of her industrial life, it is high time America should utilize at home her natural resources, aided by particularly favorable conditions. The study of this branch of metallurgy seems to offer splendid chances to many an American youth with a technical turn of mind, as the field is but little exploited as yet and promises a great future.

These rare metals, or better their salts, are also used in the chemical and color industry and, while there is a great variety in their application, their importance in these lines will always remain secondary to that as steel hardeners.

TANTALUM. Another rare metal, which has attracted universal attention during the last two years, while before it was scarcely known outside of some scientific laboratories, is tantalum. It was first discovered and investigated in 1802 by a Swedish chemist, named Ekelberg, who, on account of the tantalizing difficulties experienced in extracting the metal from its ores, called it "tantalum," deriving this name from the ill-fated king Tantalus, well known to students of Greek mythology. Only two years ago was it found out by German scientists that what the discoverer thought to be tantalum was an alloy of it and a carbide, and more tantalizing efforts were necessary to produce this metal in its perfectly pure state; but this success once being reached, the metal immediately became of such an importance that it is now revolutionizing at least one large industry, that of the manufacture of incandescent lamps for electric lights. The German chemists, experimenting with this unique metal, were connected with the well-known firm of Siemens & Halske, of Berlin, manufacturers of electrical machinery and apparatus, and they thought this evolution

of such importance that they protected their process of extraction and utilization of the metal by more than two hundred patents in all civilized countries.

The so-called tantalum lamp is an incandescent electric lamp with a filament made of a very fine tantalum wire instead of a carbon filament as in the ordinary incandescent bulbs. The most salient features of the tantalum lamp are that, while the filament is so arranged as to have a total length of about two feet, without materially increasing the size of the lamp, but half of the amount of current is needed to produce a light of the same intensity as that of an ordinary lamp with a carbon filament, and the light is so much brighter and whiter and the life of each lamp is at the same time increased so considerably that, in view of all these advantages, it would be more economical to pay one dollar for a tantalum lamp than to get the old carbon lamps for nothing.

It is most remarkable and without precedent in the history of any rare metal, how quickly the supply has responded to the demand. Prior to this invention the whole world's production of tantalum-bearing minerals was too small even to supply all museums and mineral collections with good specimens; now Australia alone has produced more than seventy tons of tantalite, the most important of these minerals, during the last year, and Norway, Sweden, France, Finland, Southern Russia and the United States have also produced appreciable quantities of tantalum-bearing minerals. In America these have mostly the form of columbite, a complex mineral with varying percentages of tantalum, niobium, iron and manganese. Considering the fact that one pound of tantalum metal is sufficient for 23,000 lamps of 25 candle power each, it is easily understood why there is already an overproduction of tantalum-bearing minerals, the price of which has consequently decreased so materially that only a pure and high-grade mineral is saleable today. There is no doubt, however, that these conditions will change as soon as other uses of tantalum are beyond the experimental stage. Although it has been tried to use tantalum as a steel-hardening agent, the mechanical difficulties in alloying tantalum with steel have been so great that we shall probably see other applications come into prominence first. Tantalum is one of the hardest substances known and its use for scientific instruments, where price stands always second to accuracy and durability, will doubtless be developed much sooner, inasmuch as tantalum also resists the corrosive influence of acids and alkaline solutions in a very remarkable degree.

One of the most striking experiments to demonstrate the hardness of tantalum was, that for the purpose of boring a hole through a sheet of pure tantalum metal, a diamond drill-bore was used, revolving incessantly for three days and making 5,000 revolutions per minute, and the result was a depression of less than 0.02 inch in the metal, but an entirely dull and smooth diamond.

A number of other rare metals have been tried for making filaments and, while some, like vanadium and niobium, have proved to be failures, OSMIUM (whose chief use in connection with IRIDIUM has hitherto been in the manufacture of high-grade writing pens—fountain pens), has led to the creation of the osmium lamp, which, however, is more of scientific than of commercial value.

A so-called Wolfram lamp, the filament of which is made of the metal tungsten, has been perfected recently and a powerful combination of Austrian and German electrical works will bring these lamps on the market in opposition to the tantalum lamp; but as the patents relating to the wolfram lamp do not seem to be clearly defined as yet, little is known of its special features and advantages at the present time, though many predict its being at least equal in efficiency and economy to the tantalum lamp, and in addition thereto materially cheaper. The near future will show whether these claims are exaggerated or not.

There is another group of rare minerals which is of the utmost importance in the illuminating industry, containing the elements THORIUM, CERIUM, YTTRIUM, ZIRCONIUM and some others, and these minerals, on account of their physical character, are generally known under the name of "rare earths."

Monazite, occurring in the form of sand, is the only commercially developed source of the metal thorium, which, since its discovery in 1828, until about a decade ago, belonged to that class of rare metals whose existence was of consequence rather in the higher range of chemical speculations than for industrial uses; but the invention of the gas-burner mantle, commonly called Welsbach mantle, shifted it at once from this class of substances into that of products indispensable to our every-day needs. The discovery of the illuminating power of thorium oxide, if combined with other chemical compositions, especially a nitrate of cerium, which is likewise extracted from monazite sand, has practically been the salvation of gas as an illuminant in competition with other lighting methods.

During the early days of this industry the sands of Brazil furnished all the commercial monazite, and trade and manufacture were

restricted by successful monopolistic efforts; but since North and South Carolina have entered the field as large producers of monazite sand and the Brazilian government has changed its restrictive policy lately, a new spirit has come over this industry and rapid strides in its development have been made during the last few years.

ZIRCONIUM, the chief constituent of the mineral zircon, and YTTRIUM, principally derived from gadolinite, furnish the main substance of the glower of the Nernst lamp, on which there exist more learned treatises than on any other lamp, but which has not come into general use. Its practical future is just as dark today as it was at the time of its birth, when an "illumination of the world" by it was promised.

The list of rare minerals which are or will soon be of importance in our commercial and industrial life is by no means confined to those enumerated above, but the study of the peculiarities of those remaining would require a predilection for chemistry. Be it sufficient then to just name one of the rest, viz., LITHIUM, well-known to everbody in the form of lithia-water and tablets. Four different kinds of stone contain the element lithium, also a metal, namely: lithiophilite, lepidolite, spodumene, and amblygonite; and while the first-named forms whole mountain ranges in the United States, it is of no commercial value. Lepidolite and spodumene are also found in comparatively large quantities, chiefly in California and the Black Hills respectively, and can be treated to advantage; but amblygonite is distinctly a rare mineral, unfortunately, since it is the one containing the highest percentage of lithia.

The lithia industry has experienced very peculiar phases since its inauguration. The United States having the largest supply of raw material, have exported "lithia stones" in considerable quantities to Europe and re-imported lithia salts; but about four to five years ago American manufacturers began to enter this field in an injudicious way, thinking that there was a practically unlimited demand for lithia preparations. They created such an overproduction that the world's markets have been glutted with lithia compounds since, and although, with but one or two exceptions, the American plants had to close down (and many in Europe also), years are necessary to free the markets from this "drug" on them; but we are now seemingly on the eve of a new era, and the United States may soon lead in the manufacture of lithia compounds and be able to export them to other countries instead of importing them, as has formerly been done.

EDITORIAL COMMENT

ROBERT P. PORTER'S admirable book just published, which arraigns "governmental interference with industrial development," is impressive because his evidence is drawn from a wide range of experience and time.* He takes the whole period of British municipalism—now about thirty years—and around the main theme of the results in the United Kingdom he groups the records of similar policy in the Colonies and on the Continent. Municipal and State gas works, electric-power and lighting stations, telephones, tramways, steamboats, housing schemes, mining, shopkeeping, have been fully tried out and tested, not by single instances merely but by their total outcome. And he finds that, however plausible the argument for the undertaking and however rosy the prospectus, the gross result is that the governmental enterprises "lead to stupendous financial liabilities, add to the burden of taxes, weaken municipal credit, bring about inequality of taxation, . . check industrial and scientific progress, stop invention, discourage individual effort, . . establish an army of officials, breed corruption . . " The worst results of all appear when the State or city attempts not only to operate but to construct public utilities, with officially hired and superintended labor. Those who believe that policy can lead to efficiency and success should read Mr. Porter's chapter on "The Public Works Policy of Australasia."

* * *

By the light which this book affords we may see more plainly how disastrous a retrograde step the Administration has taken with the Panama Canal enterprise. Little more than two months ago, Fullerton L. Waldo, fresh from the Isthmus, brought into our office his convincingly true picture of the work as it then was, full of health, energy, courage, and achievement. The engineering control, more nearly than ever before, had approached to the system of the great civil works described elsewhere in this number. The adoption of the contract plan was soon to furnish the supplementary means of keeping the execution on a corresponding basis of business economy and efficiency. And then—the tension between engineering and political ideals rose too high, and the connection was broken. Just where or how it happened may not be told, but the forces producing the result are certain. They are the same which are arrayed whenever political bodies undertake the control of constructive enterprises. Porter phrases it concisely: "Recommendations urged by the technical staff are ignored, and the personal efficiency of the latter is discouraged, so that the adoption of ordinary business principles is impossible." Then the technical chief, if his devotion to professional principles is greater than his desire for place or his subjugation to the Governmental system, gets out.

Indeed, if professional standards are to mean anything, that is all he can do. It is the peculiar province of the professional man to accomplish his employer's purposes by directing that employer's course. Would Osler manage a hospital, or Choate try a case, or Morgan finance a railway, on any other basis? If his technical knowledge and his skilled methods are to be set aside, he counts for naught. His mere name and personality is but a delusion and a snare. To remain would be to sacrifice his own reputation fruitlessly, and by reflection to compromise his calling. Withdrawal is the final protest, the

* The Dangers of Municipal Ownership. Robert P. Porter, Director of Eleventh U. S. Census. The Century Co.

public submission of the issue to the world, or to so much of it as may have an interest at stake. The United States should deal fairly between the parties and wisely for itself in examining thoroughly the issue on the Isthmus.

The President, acting wholly within the powers given him by the Spooner Act, has passed by the staff drilled under Stevens and familiar with the work, and has given army men all the upper posts on the Isthmus. An overwhelming military majority is placed on the Commission. All bids for contract construction are rejected. The decision is plainly to abolish the conflict between civil-engineering ideals and bureaucratic methods by eliminating the civil engineer and putting in the military man, trained under the departmental ways and tolerant of any conditions those ways may involve. As a soporific, this plan ought to succeed. It is inconceivable that a lieutenant-colonel of engineers should seriously withstand the Secretary of War or the Commander-in-Chief. A brigadier general or a rear admiral could not be strenuous before Congress if (say under the plausible influence of transcontinental railways) continuing appropriations for the Canal were cut so far that work languished and stagnated. His code forbids him to question the import of any policy of the Government, but exacts from him its strict execution. All honor to his splendid devotion—but will the outcome be speedy or economical building of the Canal?

Take the time and cost of any piece of work done under the Department of War; multiply it up to the proportions of the Canal, and look at the total. Ambrose Channel happens to be the nearest to this office, and will serve as well as any. It was undertaken in 1899 and is about half finished. Sixteen years may see it through. Measured roughly by comparative cost, the Panama Canal is fifty time as great: $16 \times 50 = 800$.

God bless the patience and the long-suffering of the army engineers! There are no finer fellows in the world. It is not the men who are to be criticized, but the system which is inseparable from the employment of these men—the red tape, the subordination of positive good to political expediency, the compromise between sound business and sectional interest, the frittering away of time in Congressional wrangling, the fractioning down of minimized estimates in Congressional appropriations. It may be the best possible system to fight under; but as a system to work under, it is utterly wasteful of time and money. And, if we mistake not, the President is especially anxious that the Panama Canal should be complete, ready for the passage of the heaviest ships, in the shortest possible time. He has gone a bad way about getting it!

And yet there is a way which promises sure success. It lies in eliminating friction, not by withdrawing the aggressive energy of the engineer, but by taking off the drag of the departmental system. It is exemplified by the great works outlined in Mr. Munby's article. Civil engineers, specialists of the highest standing, in control, responsible to their employers' purposes—responsible by their one priceless asset, their reputation for "getting results;" contractors of the highest type doing the work, responsible by bond for true performance; Congressional action concentrated on the one great issue of bonds; departmental methods limited to the supervision of the stated payments. It is the way all the large work of the world is done. The great railways employ it, because it gives them the surest results, in the shortest time, at the lowest cost. They employ it though they are essentially engineering organizations, officered by engineers, with an army of trained labor under their command.

Ah, the pity of it—that the Administration should rush in upon a policy by which organizations so much better fitted to handle a proposition of the kind yet fear to tread!

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE SUBSTITUTION OF ELECTRIC MOTORS FOR STEAM LOCOMOTIVES.

A DISCUSSION OF THE SUPERIORITY OF ELECTRICITY OVER STEAM AS A RAILWAY MOTIVE POWER.

Lewis B. Stillwell and Henry St. C. Putnam—American Institute of Electrical Engineers.

THERE are, at the present time, few subjects of such scientific and practical importance as the question of the electrification of steam railroads and there are but few to which the engineering world is giving more attention. Interurban electric lines have demonstrated their ability to compete successfully with steam railways on short hauls in both passenger and freight traffic and many steam railroads, in both Europe and America, have substituted electric for steam traction on their suburban and short interurban lines. The question of the electrification of steam railway lines usually presents itself in connection with particular cases where special conditions emphasize the advantages of electric traction, but the recent great development in electric machinery, particularly in railway equipment, has reached a point where it is not unreasonable to consider the possibility of the application of electric traction to the operation of railway divisions and even to trunk lines. The paper by Lewis B. Stillwell and Henry St. Clair Putnam, read at a recent meeting of the American Institute of Electrical Engineers, is an important addition to the discussion.

"Three-phase and single-phase alternating-current railway motors are now developed to a point where they fairly challenge the steam locomotive, even in long-haul freight service, in which class of work the direct-current motor hitherto has found itself unable to compete with success. The direct-current motor has demonstrated impressively, and on a large scale, its superiority to the steam locomotive, not only in operating single cars and short trains on lines of moderate length, but also in frequent and heavy passenger service in which the length of train is limited only by the length of station platform, while the motive power equipment far exceeds in power developed the limits hitherto established in steam passenger service.

"In the New York Subway, eight-car trains weighing 320 tons are in operation, equipped with motors developing during acceleration a tractive effort equivalent to a draw-bar pull of 55,000 lb. The heaviest passenger locomotive used on the Erie system weighs, exclusive of tender, 206,000 lb., of which 115,000 lb. is effective on drivers. Assuming the adhesion to be 20 per cent., such a locomotive exerts a draw-bar pull of 23,000 lb. The motors of the eight-car electric train of the New York Subway, therefore, exert a tractive effort equivalent to more than twice the draw-bar pull of this locomotive."

Discussing the earning power of electric lines, the authors mention eight important considerations which tend to secure for electric railways an increase of earning power over those operated by steam. These are, briefly:

1. The ability to run trains on close headway on electric lines gives a frequency of service which has a great effect in the creation of new business.

2. In electric traction, the elimination of

the unbalanced reciprocating parts of the steam locomotive makes it possible to operate safely at much higher speeds than are permissible on steam railways.

3. The cleanliness and the superior heating, lighting, and ventilation systems of cars and trains operated by electricity add greatly to the general comfort of passengers. The absence of smoke and gases of combustion frequently gives the electric motor a controlling advantage in tunnel service.

4. There are several considerations which lead to the conclusion that electric traction is materially safer, so far as the traveling public is concerned, than steam traction. The most important of these are:

(a) In rear-end collisions the power can be shut off with great promptness and there is much more danger of fire from the firebox of a steam locomotive than there is from a short circuit in electric traction.

(b) The absence of the steam boiler eliminates another element of risk.

(c) Signals can be seen clearly at all times on account of the absence of smoke.

(d) Electric heaters are much more convenient and eliminate a risk of fire.

(e) The use of electric light is much safer than that of oil or gas.

(f) The danger of derailment is far less on account of the elimination of the unbalanced reciprocating parts which tend to lift the steam locomotive from the tracks.

(g) Much better signal systems can be arranged than are possible on steam roads.

(h) Power can be cut off at will from a given section and this makes for additional safety in offering a means of averting head-on collisions under certain conditions.

On the other hand, the addition to the permanent way equipment of an electrical conductor conveying power to trains imposes a material risk not present in steam railway operation.

5. Careful investigation of the official records of the causes of delay on the Manhattan Division of the Interborough Rapid Transit system of New York which was formerly operated by steam, point to the conclusion that a more reliable service is to be had with electric motors.

6. The better acceleration possible with electric traction increases the capacity of the line by making possible a shorter headway and train interval.

7. An electric line can more easily collect and distribute passengers on account of the ability of the cars to stop at any street intersection or other convenient point.

8. Feeder lines can be easily established and a more convenient arrangement of local and express traffic can be made.

In comparing the costs of operation of steam and electric roads, the authors take as their standard of comparison the grand average results in steam operation in the United States for the years 1901-5, inclusive. A great part of the paper is devoted to an elaborate analysis of operating costs. Basing their conclusions on the best available data on electric railway operating costs, the authors state that the cost of electric operation is only 82 per cent. of that of steam. They then consider the question of the electrification of all the steam roads in the United States.

"According to our estimate if all the railroads of the United States were to-day operated by electricity, using the single-phase alternating-current system at the potential adopted for the equipment of the New Haven Railroad the energy required for operation being developed by power plants, such as are to-day in extensive use, and transmitted at potentials well within limits established in practical service, and if the rolling stock equipment consisted of locomotives and multiple unit trains fitted with motors and control apparatus no better than the best which now exist, the aggregate cost of operation, which in 1905 amounted in round numbers to $1,400,000,000, would be reduced by about $250,000,000.

"To accomplish this result power plants delivering about 12,500,000,000 kw.-hr. per annum would be required. Assuming the radius of transmission from power houses to be 150 miles the load factor in railroad service should be not less than 0.75, and taking this figure it appears that power plants capable of delivering a maximum output of about 2,800,000 kw. will be sufficient to operate the entire railway service of the United States as existing in the year 1905. The average output required is about 10 kw. per mile of line and 7 kw. per mile of track.

"In 1905 the average gross earnings of our railroads per mile of line were $9,598, and the average operating expenses $6,409. Our calculations lead to the conclusion that high class electric equipment now available would reduce this average cost to $5,265. The difference is $1,144 per mile of line, against which apparent saving must be charged the annual interest and depreciation of the power plant, the addition to permanent way equipment, comprising overhead construction and track bonding, the transmission circuits, and the substations with their equipment. Assuming 5 per cent. interest on cash cost of these items and allowing 5 per cent. for a sinking fund to cover depreciation of power house, with its equipment, and 2½ per cent. for a sinking fund to cover depreciation of the overhead construction and distributing system, the aggregate of fixed charges works out at $837 per mile of line. The saving in operating expenses, therefore, is more than sufficient to take care of the increase of fixed charges. In other words, it appears that the entire railroad system of the United States could be operated to-day at less cost by the electric motor than by the steam locomotive. That the railroads in general if so equipped would realize a large increase in earning power will be admitted by all who have given the subject intelligent attention.

"While our estimates have led us to the conclusion that, under average existing conditions of railroad operation in the United States, improved financial results would be attained by the substitution of the electric motor for the steam locomotive, the immediate and general adoption of the new motive power by our railroad companies is neither possible nor desirable. It requires no argument to demonstrate the wisdom of making haste with deliberation in a matter involving interests of such magnitude as those which are tied up with the transportation systems of the United States. Recognizing the magnitude of these interests, and having in mind the fact that the art of electric traction as applied upon a large scale to heavy train units is yet young, the point which we desire here to emphasize is the necessity of conservative and carefully considered action upon the part of all who may be called upon to advise in respect to the electrification of railways now operated by steam."

The paper concludes with a statement of the necessity for careful and intelligent standardization in electric traction and with a discussion of the advantages of a frequency of 15 cycles over a frequency of 25 cycles in electric railway operation on account of the better adaptability of the lower frequency to motor design. The authors conclude:

"In order that the question raised may be looked at in proper perspective the following estimates will be useful:

"For the equipment of the entire railroad system of the United States as now existing an aggregate power house output capable of supplying continuously 2,100,000 kw. would be required. Of the electric apparatus installed in the power houses, a change in frequency affects the generators, transformers, and a large proportion of the measuring and indicating instruments. It also affects the cost of the engine or turbine employed to drive the generator. At 25 cycles, the apparatus affected by frequency should cost approximately $30 per kilowatt. At 15 cycles it would cost on the average perhaps $33 per kilowatt. Cost of substation transformers would be increased approximately one-third, and in round numbers the total cost of turbines and electrical power house and substation apparatus would be increased from $70,000,000 to $80,000,000.

"If it be assumed that one electric locomotive will do the work of two steam locomotives, about 24,000 electric locomotives would be required to take care of the present railroad business of the country. Assuming the cost of the average electric locomotive to be $25,000, the aggregate cost of locomotives required would be $600,000,000. Allowing for the increased cost of the 15-cycle transformers, it would seem that the difference in cost of the average locomotive should be not less than $1,000 in favor of the lower frequency, or for 24,000 locomotives $24,000,000. This is more than twice the estimated difference in cost of power house and substation equipment.

"It seems entirely safe to say, therefore, that the aggregate first cost of electric equipment and of steam turbines will be decreased by a change from 25 cycles to 15

cycles. The operating cost will obviously be decreased very materially. At least three-fourths of the above estimated cost of electric locomotives, say $450,000,000, represents cost of electric equipment. It will be seen, therefore, that of the apparatus which our electrical manufacturing companies may be called upon to furnish, more than 85 per cent. is rolling stock. Obviously, any argument in favor of 25-cycle equipment which may rest upon existence of drawings and patterns and convenience in manufacturing should have comparatively little weight."

RECENT EUROPEAN LOCOMOTIVE DESIGN.

EXAMPLES OF IMPROVED ENGINES EXHIBITED AT THE NUREMBERG AND MILAN EXPOSITIONS.

Zeitschrift des Oesterreichischen Ingenieure- und Architekten-Vereines.

THAT considerable attention is being paid in Europe to the improvement of locomotive design was amply demonstrated by the exhibits of improved locomotives at the Nuremberg and Milan exhibitions. Articles in a recent number of the *Zeitschrift des Oesterreichischen Ingenieure- und Architekten-Vereines* illustrate and describe several of these engines and the following abstract gives a few examples showing the trend of modern European locomotive design.

Of the recent passenger locomotives built in Europe, there are two prominent types, the Atlantic and the Ten Wheel, the 4-4-2 and the 4-6-0 types; and while many of the four-coupled 4-4-0 type have been built, they are being gradually but surely replaced by these two styles. For several years locomotive experts in Europe have been making exhaustive service tests of compound cylinders and of superheated steam, and they appear to be so satisfied with the results of their experience that these two features are more noticeable than any others in present Continental locomotive design. Furthermore, while some designers in the United States are questioning the economy of steam at higher pressures than 185 lbs. per square inch, all new locomotives built in Europe are carrying pressures ranging from 215 to 230 pounds per square inch.

Some very interesting locomotives have come into use during the last year in France, Germany and Austria. One of these is of the Atlantic (4-4-2) type, a four-cylinder compound, with cylinders 14 3/16 and 24⅜ inches diameter by 26 inches stroke, driving wheels 82⅝ inches in diameter, a broad firebox with 42 square feet of grate surface, and 2,823 square feet of total heating surface and a total weight of 164,000 pounds. It was built for the Hungarian State Railways and, in accordance with a practice growing quite common, has the front of the stack, cab, and smokebox pointed for the purpose of diminishing air resistance. Another interesting fact about this engine is the use of a Vanderbilt tender. This is generally used for this particular group of locomotives, of which several are now in service and more are to follow.

The four cylinder compound Atlantic locomotive is not by any means an innovation, as a large number have been put in service during the last five years in Austria. The first was designed by Karl Gölsdorf, the compounding being according to his system. The more recent compounds, however, are larger and more powerful and have somewhat different proportions, embodying such changes as have been found desirable from service conditions.

For the Bavarian State railways a locomotive has been built of about the same tractive power and heating surface as the one first described, but somewhat heavier. In order to accommodate the larger firebox desired, a four wheel truck was put under the rear end of the engine; hence it is called a 4-4-4 modified Atlantic. It has a very long wheel base, 38 feet 4½ inches, but it is evidently sufficiently flexible to avoid excessive flange friction in going around curves. The cylinder and driving wheel dimensions are nearly the same as those of the engine first described, but the grate area is 50.6 square feet, and the engine weighs 185,000 pounds. It is equipped with a superheater.

The State railways of Belgium have put in service two designs of four-cylinder

compound ten-wheel engines, the 4-6-0 type. One of these has all four cylinders set on the same transverse line, under the smokebox; the other has the well-known De Glehn arrangement of cylinders, that is, the low-pressure cylinders between the frames and under the smokebox, and the high pressure outside the frames and back of the forward-truck wheels. They are both of about the same tractive power and weight and have high-pressure cylinders 14⅛ inches in diameter, low-pressure 23⅝ inches, and a piston stroke of 25 3/16 inches. With drivers 71 inches in diameter, this makes a powerful locomotive with steam at 228 pounds pressure. These are also equipped with superheaters. While many other locomotives were shown at Milan and Nuremberg, those mentioned represent the present trend of design.

One other type, the Prairie (2-6-2), which, like the Atlantic, originated on American railroads, has been tried to a limited extent, and the Florisdorf Works at Vienna have just built a few four-cylinder compounds for express service on lines with heavy grades of the Austrian State Railways. These engines more nearly resemble their American prototypes than any others in Europe.

One of the first features that causes comment on the part of an American examining these European locomotives is their extreme lightness and apparent delicacy of construction. The piston rods, side and main rods, all parts of the valve gear, as well as the wheels, are made of steel the tensile strength of which is much higher than any material available for such use in the United States. In the latter country, it is not only a question of the expense entailed by the use of such metal, but master mechanics and mechanical engineers are forced to admit that it cannot be procured outside of Europe. Further, in Europe, innovations on locomotives are tried out with the sole end in view of effecting economy of operation, and the enginemen as a rule take more interest in obtaining results and thus gaining premiums for themselves, than is the case in the United States. Hence the complications and cost of repairs for compound locomotives are much less than the coal saving effected by their use. The same is gradually being found out in regard to superheated steam, though it is not so clearly established as compounding, which is now standard practice in Europe.

It must be remembered, however, in considering locomotive performances, that the quality of the coal obtainable in most parts of Europe is excellent, not only the loose coal, but the briquettes that are in common use. While fuel is expensive, it is burned to the greatest advantage owing to the custom of not overloading engines, forcing fires and risking the various kinds of trouble that Americans have come to regard as unavoidable owing to their conditions of traffic.

INSURANCE OF LABOUR IN ITALY

NATIONAL REGULATION OF LABOUR INSURANCE IN ITALY AND ITS RESULTS.

Engineering.

THE question of the insurance of workmen against accident is one which has received little attention in America. Its importance has, of course, been recognized and a great many large employers of labour, particularly in the building trades, regularly insure their workmen in the ordinary accident insurance companies. The practice is, however, not common and no concerted or systematic action on the part of the employers has been taken to arrange some mutual or national scheme of labour insurance. Nearly all European countries, on the other hand, have established national systems of insurance to which all employers of labour are required to become subscribers. Italy is the last country to institute such a system and a summary of the Italian law on the subject is contained in a recent number of *Engineering*.

"The Italian law which deals with the compensation to workmen for accidents is dated January, 1904; in this law there are also grouped together all former decrees dealing with the question. It covers all industries and trades; all installations and enterprises in which there are more than

five operatives; fisheries; all establishments in which motive power is used, and where over five persons are employed. In the building trades the employers are responsible, even when the number of operatives is below five, when work is being executed outside buildings, with the use of planking, fixed and movable scaffolding. The following are considered as operatives under the law:—All those who, either permanently or temporarily, are occupied for a daily wage, or on piecework, away from their homes; those who, although not participating directly in the work, superintend the work of others, provided their fixed wage does not exceed 7 lire (5s. 7d.) per day, payable in regular periods not exceeding one month; apprentices who take part in the work, with or without wages; and attendants on agricultural machinery.

"All employers of labour have to insure against accidents. Should the job not be permanent, an insurance has to be effected to cover the time it lasts. Those employers of labour who attempt, by direct or indirect deductions from the operatives' wages, to make the latter contribute to the cost of the insurance are liable to a fine not exceeding 4,000 lire (160*l.*). An incorrect declaration as to the number of men employed is also punishable by a fine of from 2*l.* to 40*l.*

"Insurance must be effected with the National Fund; but the following firms are exempted from this form of insurance:—Those who have instituted at their own cost private funds recognised by Royal decree, and who have deposited with the National Fund a guarantee consisting of State, or trustee, securities to an amount fixed by the Ministry of Agriculture, Industry, and Commerce. Such a fund must be able to provide compensation for accidents at least equal to that prescribed by the law to a number of operatives exceeding five hundred. The sum deposited as guarantee is in no case to be below that of five times the premium that would otherwise have to be paid annually to the National Fund when the operatives number two thousand, and three times the premium if the number of operatives exceeds two thousand; in both cases the minimum is 40,000 lire (1,600*l.*). There are also excepted from the obligation to insure with the National Fund the firms who have combined together for mutual insurance, on bases approved by the State, who employ at least four thousand operatives, and who deposit as security with the National Fund 10 lire (8s.) per operative insured up to a maximum 250,000 lire (10,000*l.*).

"The compensation for accidents paid the operatives is as follows:—In the case of absolute permanent incapacity for work, the compensation is equal to the sum of six years' wages—minimum, 3,000 lire (120*l.*). In the case of partial, but permanent incapacity for work, the compensation is equal to six times that part by which the wages are reduced, or may be reduced, by reason of an accident, the minimum to be 500 lire (20*l.*). Should the incapacity for work be complete, but, nevertheless, temporary, the indemnity paid the operative during the time he is out of work is a daily sum equal to half the daily pay he received at the time the accident occurred. When the accident has caused partial and temporary incapacity for work, the daily compensation is equal to half the reduction in the daily pay. In all accidents the contractor, or his representative, has to bear the cost of first aid and of a medical certificate. In case of death, the indemnity is equal to five years' wages. This sum is divided as to two-fifths to the consort (husband or wife), and three-fifths to the children who are under eighteen years of age, or who are physically or mentally incapable of working. Should there be no children, or should the latter be able to earn their living, half the indemnity is paid to the consort, and the other half to the descendants who were dependent upon the deceased. Should there be no children or descendants, but yet brothers or sisters of deceased who were dependent upon him, less than eighteen years of age, or physically or mentally incapable of work, the latter receive the remaining two-fifths, the consort taking three-fifths. Should there be no children and no other relatives as here stated, the consort would receive the whole of the indemnity. Should the deceased have been alone in the world, the indemnity is paid into the deposit and loan fund—a fund into which are also paid the fines above alluded to—to be used for indemnifying the operatives who would have

received no compensation for an accident, by reason of the insolvency of their employers. This fund serves also for subsidising the associations who aid the operatives during the first five days of sickness; for providing prizes in favour of inventors of protective devices; and for subsidising the societies who supply medical treatment to injured operatives.

"Indemnity to apprentices is based upon the wages of the lowest paid operatives engaged on the same work.

"By annual wage is meant that paid during the twelve months preceding the accident, in cash or in truck, up to a maximum limit of 2,000 lire (80*l.*). In the case of operatives who had been employed less than twelve months when the accident occurred, but not less than six, the annual wage would be reckoned as 300 times the daily pay in cash or in truck, unless the wage had been agreed upon for an annual figure, the maximum in both cases being also 2,000 lire (80*l.*). When, from the nature of the work, or for other reasons, the operative would be employed for less than six months, and whatever shape the compensation takes, the daily pay and annual wage are determined, if need be, by the Court.

"After a period of two years following an accident the operative and the insurance office are at liberty to consider the revision of the indemnity, should the estimate first arrived at have proved erroneous, or should the physical condition of the operative have undergone changes traceable to the accident. Should the operative die before the expiration of the term of two years from the day of the accident, his heirs-at-law may claim the revision of the indemnity; but their claim has to be put forward within two months from the death of the operative and still within the two years aforesaid.

"In the case of permanent absolute incapacity for work, and in that of permanent and partial incapacity, when the reduction on the annual wage for the fixing of the indemnity is at least half the said wage, the compensation above-mentioned is deposited by the insurance office with the National Provident Fund, instituted for affording relief to invalid or aged workmen, from which an annuity is paid to operatives, or their heirs-at-law. The compensation in question is due in all cases from the employers; the latter are compelled to insure in some accepted form against labour risks, but have a free choice with regard to the selection of an insurance company, or the formation of an association for insurance; both have, however, to be approved by the State.

"The law stipulates in a general way that safety devices shall be used for the protection of labour; it then details the compensation which has to be paid in cases of accidents, briefly reviewed in the foregoing. Judging from the comparatively numerous clauses which provide for judicial action in the event of disputes with reference to the application of the law; seeing also the various penalty clauses which apply to employers of labour—a very curious feature of the measure—difficulties were evidently foreseen and doubts were entertained as to the satisfactory working of the law in question. The law is, no doubt, found one-sided, both by operatives and employers. And in this connection it is interesting to put on record an article which appeared in a recent issue of the Milan technical paper *L'Industria*, written by an employer of labour, whose works occupy about 1,800 operatives. In this article the employer calls attention to frauds which have been perpetrated since the coming in force of the law of January, 1904. It seems hard to believe that workmen would get injured willingly with a view to receive compensation in cash; but it is difficult to find any other explanation of the facts. Firms who had always compensated their men many years before the law came into force, and at a period when protective devices were hardly used at all, do not seem able now to cope with the untoward increase in accidents and claims for compensation. The writer of the article in question gives the instance of his own works, and says: 'The experience gained on the subject in our own works is to the point; we have about 1,800 operatives, and at the present time the increase in claims for compensation under the law is 40 per cent. over the figure of several years ago, when we, of our own free will, and without State compulsion, insured our men, and when a large number of protective devices to prevent

accidents now in use were unknown.' According to another report, the number of accidents caused by engines, lifts, motors, and shafting has decreased of late, while the number of falls and accidents in hand-labour have doubled, many other claims being for cases of arthritis and rupture, traced invariably by the men to their work for the employers, and for which they claim the benefit of the law, aided in this by unscrupulous medico-legal advisers.

"The National Provident Fund, above referred to, was formed in July, 1898; it is governed under a law dated July, 1901, completed by statutes and regulations approved by Royal Decree of May, 1902. All Italian subjects are free to pay deposits into the fund for securing an old-age pension or a pension in case of disablement, and the State has endeavoured to encourage thrift on the part of the subjects, not by adding to the individual deposits made by them, a given percentage, as is the case in Belgium, but by paying subsidies direct to the fund. Thus the State, in the first place, endowed the fund with 10 million lire (400,000*l.*) from sums in the Treasury from savings and deposit accounts, and also part of the profits of the Post Office Savings Bank. Various other payments and contributions have been, and are being, made to the fund in question; among others may be mentioned a tenth part of the credit for public worship."

THE REVIVED CHANNEL TUNNEL PROJECT.

THE SUPERIORITY OF A TRAIN FERRY SYSTEM OVER A RAILWAY TUNNEL AS A MEANS OF COMMUNICATION BETWEEN ENGLAND AND THE CONTINENT.

J. Wolfe Barry—The Nineteenth Century.

TWENTY-FIVE years ago, when a tunnel under the English Channel affording railway connections between England and the Continent was first proposed, *The Nineteenth Century* was one of the most vigorous opponents of the project. Recent events have again brought the question into prominence and the February number of that magazine presents a symposium of articles dealing with the military, political and financial aspects of the scheme. The following extracts are taken from an article by Sir John Wolfe Barry in which he discusses the possibilities of a train ferry system as opposed to the tunnel project.

"Leaving the military issues to others, I would point out that physically the difficulties in making the Tunnel might prove to be insuperable, for if any serious fissure in the chalk were encountered, no human beings could work under such a water-pressure as would be developed. I do not mean to prophesy that such a fissure will be met with; on the contrary, I think the information collected points the other way, but the non-existence of a fissure cannot be demonstrated until the full-sized Tunnel is completed throughout its entire length, and even the making of a heading from shore to shore will not guarantee that no fissure will be encountered in the larger cross-sectional area of the Tunnel itself. No one can deny the possibility of such a disaster, and it is a matter which certainly ought to be considered as of great weight in the balance of pros and cons of a Channel Tunnel.

"Then again there is the financial side of the question, assuming that all is well in the matter of construction. Is it possible that the net realizable traffic from a Channel Tunnel can pay interest on such an expenditure as is talked of, say sixteen millions of pounds, or on a cost of some 600,000*l.* per mile? Under the circumstances of the case, and with water competition both for goods and passengers still remaining, it seems to me impossible that the financial result can be even moderately successful. So far as this country may be asked to bear its share of the financial burden, it may be said that the capital expenditure and working expenses should be apportioned in view of the mileage affected, inasmuch as the Tunnel is expected to increase the traffic on the mileage of the existing railways in the two countries. If so, the shorter mileage between London and Dover as contrasted with that between Calais and Paris would indicate that the lion's share of the expenditure should fall on France. However this might be ar-

ranged between the two nations, the expenditure of 16,000,000*l.* of hard cash for improved means of communication—while the sea competition will always exist not merely between Dover and Calais, but also between all the ports of the two countries, strikes me as a financial difficulty of the first order. From this point of view the Channel Tunnel is obviously very different from the great tunnels which pierce mountain ranges."

A tunnel is not the only means by which improved communication facilities may be obtained. A railway ferry offers most of the advantages of a tunnel and avoids many of its difficulties. A Channel ferry was proposed in 1872 by Sir John Fowler and was again advocated by him in 1882 when the tunnel agitation was first at its height.

"Much has happened since 1882, and the views of that date have been amply borne out by much subsequent experience. We know of railway ferries in many countries by which both goods waggons and passenger railway rolling stock are conveniently interchanged across intervening seas and lakes for distances far exceeding that between Dover and Calais, and under conditions of sea exposure at least as great as between Dover and Calais. On the line of communication between Berlin and Copenhagen, as an instance, but also in many situations, we know that, besides the ordinary rolling stock, restaurant and sleeping cars cross the ferries, and that passengers habitually make their journeys in the cars.

"It cannot thus be denied that the scheme of a railway ferry across the Channel is perfectly feasible, and could be made convenient and even luxurious, avoiding all break of bulk for goods, and all change of carriage by passengers, unless a change to the deck of a large steamship be preferred. Sir John Fowler proposed to treat his ferry ships for passengers as large railway stations, with waiting room, refreshment rooms, and every modern requirement. The only obvious drawback is that all risk of sea-sickness cannot be eliminated by a railway ferry. But with ships of the large size required for the traffic between England and France, the chance of seasickness would certainly be immensely diminished, and its discomforts would be palliated by improved cabin accommodation for those who could not sleep in a sleeping car through the hour of sea transit, or could not afford the expense of a *train de luxe*. I do not wish to advance the idea that in heavy weather a large steamer will not occasionally be unpleasant between Dover and Calais. That sea-sickness, however, would be very greatly mitigated there can be no doubt, and we may well ask whether, for the total elimination of occasional sea-sickness of an hour's duration for a comparatively small number of persons, it can be worth while to spend so many millions or to incur grave national risks."

Dover harbour is much better fitted today for the establishment of a railway ferry than it was in 1872 and only a small amount of alteration would be necessary. At Calais better harbour accommodation than at present exists would have to be arranged for. Boulogne, which is four miles farther from Dover than is Calais, has much better harbour works than the latter, but not a sufficient depth of water. Both French ports are important railway centres, Calais for lines to Belgium, Holland and the North of Europe, and Boulogne for lines to Paris, Switzerland, and the South of France.

"With the knowledge of what can be done on sandy shores by a modern dredging plant, it is, I venture to say, merely a question of which position offers the greatest advantages, all things considered. We have only to look at the development and maintenance of deep water approaches to such ports as Ymuiden, Dunkirk, Liverpool, Durban, and Port Said, all on sandy coasts, to see that a good French harbour for the railway ferry presents no difficulties, and would not involve more than a very small fraction of the cost of a Channel Tunnel. It is obvious that money spent on any of the French ports would be for the advantage also of general trade, which is a point not to be lost sight of by our allies in considering the cost of installing a railway ferry with large ships.

"It must, of course, be admitted that the journey would be shorter in time by a Channel Tunnel; but here, again, the comparative shortening is not of much importance. The ferry would, I suppose, provide a speed of twenty-three knots, or near-

ly twenty-seven statute miles, an hour, and the railway speed through the Tunnel may be assumed at about forty-five statute miles an hour. If we may assume that some stoppage for the exchange of electric engines and other matters takes place on the railway at both ends, such stoppage would, wholly or in part, counterbalance the time expended in running the trains on to and off the ferry steamers. Considering the relative velocities of the train and ship, we may probably with sufficient accuracy arrive at a difference of time of about thirty minutes in favour of the Tunnel route. . . . . As in the case of sea-sickness, it does not seem reasonable to incur the risks and cost of a Channel Tunnel for a saving of half an hour, more or less, for passenger traffic. . . . .

"There is one other matter to which allusion has not been made—viz., the comparative working expenses of a tunnel and a railway ferry. It is a question which must, I think, remain indeterminate. In the case of the tunnel the traffic would be conducted over adverse gradients of considerable length in one or other direction, the cost of which is calculable, but we have no data for the expense of ventilating so long a tunnel, to be worked, no doubt, electrically, but approached at both ends by gradients descending to a very considerable depth. The wind and weather on the two coasts will much affect the question of ventilation from day to day, and we also cannot know what (if any) pumping of infiltrated water in the tunnel may be required. In view of the rainfall and land water on the approaches and condensation, we may, I think, be sure that provision for pumping will be a necessity, but what the annual cost of it may be it is impossible to say. In working the ferry, on the other hand, there would be the expenses of a separate organization of ships, of shipping and unshipping the trains, of harbour dues, and insurance against sea risks.

"On the whole, I think that for the present purposes the working expenses may, in the comparison of the two projects, be neglected. It is impossible, as I have said, with our present knowledge to indicate on which side the advantage would be. In the case of the ferry a fairly correct estimate of annual expenses might be made for a given traffic, but this is not the case in regard to a tunnel such as is proposed.

"The conclusion from all the above considerations must, I think, be that for a very small part of the cost of a tunnel a railway ferry with the most modern improvements could be installed which would fulfil almost all that a Channel Tunnel could provide. In those things in which the ferry would fall short the issues are nearly immaterial. There could be no difficulty in estimating the cost of the ferry, with its harbour works, and the working expenses could be arrived at, while its beneficial effect in uniting the two countries and increasing interchange of traffic must be undoubted. On the other hand, there are many undefined eventualities in the case of a tunnel, the expenditure must be enormous, and success cannot be guaranteed."

ELECTRIC-POWER DEVELOPMENT IN SAVOY.

THE THURY SYSTEM OF HIGH-TENSION DIRECT-CURRENT GENERATION IN FRANCE.

J. A. Montpellier—L'Electricien.

THAT portion of France adjoining Italy and Switzerland, south of the lake of Geneva, and comprising the provinces of Upper and Lower Savoy, contains a large number of streams available for power development, and engineers and capitalists have not been slow to take advantage of the opportunities afforded. Most of the streams have their sources in the Alpine glaciers, and while many are small, their fall is considerable, and they may be said to furnish practically all the power required in the region mentioned. The industries of the district are varied; many small mining and manufacturing plants are operated by electric power and, in addition, the lighting of the many villages and towns constitutes a considerable part of the load at most stations, and the entire load at a few of them. A portion of the Paris, Lyons, and Mediterranean railway, from Fayet to Chamounix, is operated by elec-

tricity from one of the numerous water-power plants. There are fifty-four generating stations scattered throughout the district; of these all but four are run by water power exclusively, one is steam driven and three have auxiliary steam plants for use during periods of low water.

Considering the area to be served, it might be more economical and more satisfactory to have fewer generating stations; but in addition to the consideration of the limited power available at most localities in Savoy, it must be borne in mind that the consolidation and centralization of public service undertakings are not such simple matters in Europe as in the United States. In the former, the policy of industrial development as commonly carried out is to treat each province or canton as a unit entirely independent of the others.

In *L'Electricien*, from recent issues of which these facts were obtained, a comprehensive enumeration of the hydro-electric generating plants is given. Of the fifty-four stations, mentioned as supplying the two provinces of Savoy, forty generate direct current, one at 57,600 volts, two single-phase alternating, and twelve, three-phase alternating current. Most of the direct-current transmission is over short distances, and on the three-wire system, with 220 to 250 volts between outside wires; for the longer transmissions alternating current at from 2,000 to 12,000 volts is employed, the usual rate of alternation being fifty per second. Some of these alternating plants also supply several substations, and as regards generators, transformers, etc., present no very new or striking features, being representative of the best European practice of to-day.

At Moutiers, on the Isére river, which near this place affords a head of 215 feet, there is an installation generating 6,300 horse power that in its electrical features is novel, well worked out, and worthy of more than a passing notice by engineers. Turbine-driven generators furnish direct current at 57,600 volts which is transmitted to the city of Lyons, a distance of 112 miles. This high-tension current is developed according to the scheme devised by M. Thury, several groups of generators being arranged in series, the voltage desired being attained by connecting a number of machines in each group and then connecting the groups in series. At Moutiers the installation consists of four turbines of 1,570 horse power each, driving four groups of generators, each turbine driving one group of four machines connected in series. At normal operation, the dynamos run at 300 revolutions per minute and each generates direct current at 3,600 volts. Thus for each set of four dynamos connected in series, the final voltage will be 14,400 volts. Since four sets of machines are thus connected, the total effective voltage at the switchboard is 57,600 volts. The dynamo shaft is direct connected to the turbine shaft by means of a clutch, but this clutch is so constructed as to allow a slip to occur as soon as the torque on the shaft varies appreciably from that of full load. This feature does not, of course, render unnecessary the circuit-breakers which are installed, but it probably helps to relieve the strain in the case of a bad short circuit by slowing down the dynamos. In such a plant as this, furnishing direct current at 75 amperes and 57,600 volts, it is vitally important to have good regulation. A small motor is installed, connected through gears to the gates in the conduits leading to the turbines. This motor is controlled by the current traversing a solenoid in the main circuit, and as the main current varies, the plunger of the solenoid operates upon the motor circuit so as to cause the motor to revolve in one direction or the other, open or close the gate to the turbine and thus alter the speed of the dynamos to suit the requirements of each case. The plant has been in operation since last April, and this feature is said to be very satisfactory.

With such a high voltage as is developed by the generators in this installation, the question of insulation becomes a serious one. Each generator is set upon porcelain blocks resting upon asphalt bedded in cement, and the same care is bestowed upon all leads and mains on and near the switchboard. No troubles with insulation appear to have been experienced, although the problem of insulation in a direct-current plant is somewhat different from that in one developing alternating current, where the high tension "danger zone" can be con-

fined to the transformers and outgoing line.

The transmission line is of copper wire, 0.354 inch in diameter, secured to triple porcelain insulators on wooden poles. It is subdivided into several sections at the ends of which either conductor may be grounded in case of damage to any part of the line. In such a case, one terminal of the generators may have to be grounded and the whole current, 75 amperes, transmitted in this way.

Whatever its economic results may be, this installation has been very successful from a mechanical and electrical point of view; and the simplicity of the direct-current machinery appeals to one on account of the absence of intermediate transforming apparatus inseparable from high-tension alternating-current plants.

BLOCK SIGNAL SYSTEMS IN THE UNITED STATES.

A SUMMARY OF THE REPORT OF THE INTERSTATE COMMERCE COMMISSION RECENTLY PRESENTED TO CONGRESS.

Railroad Gazette.

IN June, 1906, a resolution of the United States Congress empowered the Interstate Commerce Commission to conduct an investigation of the block signal systems in use in the United States, and a report of the results of the investigation has just been presented. The report includes a mileage table of block signal systems, a review of the history of block signals and of present practice, a discussion of automatic stops, and an appendix containing technical notes on signal appliances and some accident statistics. The presentation of this report is very timely in view of the numerous disastrous collisions which have occurred within the past few months and some of the conclusions and recommendations of the Commission, as abstracted in the *Railroad Gazette*, are given below.

"The salient facts shown in the statements which have been received from carriers are that—

(1) Fifty of the principal railroads of the country have introduced and are using the block system on their important lines, though with considerable difference in details of apparatus and methods of operation.

(2) The telegraph block system is operated at moderate expense, with a great improvement in safety as compared with former methods of train control.

(3) Automatic block signals, almost universally looked upon in this country as the highest exemplification of the art, have been and are being developed with great energy and skill and liberal expenditures of money.

(4) Automatic signals are superseding the telegraph block system to some extent, and seem destined to do so increasingly in the future.

(5) Thirty roads of considerable length and importance have not yet adopted block signals of any kind.

(6) The block system has proved decidedly profitable even on lines where the signal equipment is not complete, this being accomplished by careful adherence to modifying rules making provisions against the deficiencies of the block system and by the continuance of the train despatching regulations which were used before the block system was adopted.

"It is proper to add that all of the railroads continue in force their rule requiring that when a train is unexpectedly detained a flagman shall go back with a red flag or lantern to stop any following train; though, as the accident records show, flagmen have repeatedly failed to stop trains that have wrongfully passed block signals.

"The main facts which have been elicited concerning the present policies of the railroads of the country in respect to block signaling are:

(1) The principal railroads use the block system on their lines of heaviest traffic, and most of them report that it is economical.

(2) Many of these roads use it also on lines of light traffic and some are rapidly extending it.

(3) All railroad officers deem the system an improvement over any other method of guarding against collisions. In other words, they consider it a means of safety.

(4) Many say that it has reduced the number and cost of collisions.

"The controlled manual system is used on the four-track lines of the New York Central & Hudson River and the New York, New Haven & Hartford. These are the principal examples of this system in the United States. It is, of course, equally adapted to two-track lines. The electric train staff, which is a type of controlled manual apparatus, is used on 100 miles of a single-track division of the Southern Pacific and on short sections of other roads. The train staff is universally approved as a safety device, but its failure to secure more general recognition appears to be due to a general feeling that the controlled manual apparatus which is used on double-track lines is perfectly adapted to single-track work, and is superior to the staff in that trains need not be stopped or slackened for the purpose of delivering the staff.

"With regard to the telegraph block system, most of the roads using it show records of long continued immunity from collision, but the 13 collisions which are referred to in this report, details concerning which are given in the appendix, with others occurring more recently and still fresh in the public mind, compel us to recognize that the system is not perfect.

"The only reason specifically formulated by any railroad manager for not introducing the block system is financial inability, except in the case of lines on which the passenger business is extremely light. Looking at the policies of some roads as they are known and at others in the only way in which they can be interpreted in the light of facts, it is quite clear that, generally speaking, the roads which have been dilatory in adopting the block system or in extending its use have simply pursued that temporizing policy which postpones appropriation of money until necessity will permit of no further postponement. An appropriation for the erection of block signals or for the expense of maintaining them is not viewed with favor because railroads operating without such signals have, in many cases, made fair records for a long time. It is true that important railroads have carried thousands of passengers for many years, with no block system, without fatally injuring a single one of them in a collision. Such a record is justly regarded with pride; but a single collision ten years hence, which is an admitted possibility, would extinguish the pride and becloud the record of the past.

"Many important roads have introduced the telegraph block system with the expenditure of very little money, simply by establishing a few new telegraph offices. There are also cases where a road, which has apparently held the view that the block system is impracticable by reason of its cost, has quickly changed its policy after the occurrence of a collision on its own line. It is true that roads which introduce the block system without increasing their telegraph facilities usually find themselves obliged, for a part of the time at least, to run freight trains under permissive blocking (which, strictly speaking, is not block signaling at all), but the action of such roads is significant because it marks decided progress. Their imperfect system protects passenger trains and it educates trainmen to the need of a space interval for all trains.

"A number of prominent roads which have shown enterprise in safeguarding their more important lines by means of block signals are continuing the old methods on other lines. A disastrous collision in the State of Indiana in November affords a striking illustration of this fact. A few roads which enjoy ample prosperity have as yet done little or nothing in providing block signals.

"The present investigation has been conducted for the purpose of setting forth the actual facts under present practices, and of affording the best guide as to what can or should be done to improve the safety of travel on the railroads of the United States. The conclusions reached confirm the views which have been heretofore expressed by the commission in its annual reports for the years 1903, 1904 and 1905. In its report for the year 1903 the commission presented the draft of a bill which provides for the introduction of the block signal system and also for the exercise of supervisory power by the commission through the employment of suitable agents and inspectors.

"Supervision is necessary, not only to in-

sure that the specific requirements of the law are complied with, but also because of differences in methods of construction and operation and in the standards of perfection and safety on different roads where the block signal system is already in use. This point was not especially emphasized by the commission at the time the bill was laid before Congress, but the present investigation has more clearly emphasized the need of such supervision. The differences of practice, etc., are reflected in the results of operation. In reporting the faults of signals and errors in operation, different companies make widely different showings. This is a vital matter in which the function of the government in securing publicity is a particularly useful one, and in which no authority other than the government can act efficiently. To investigate accidents, as is done in England and to some extent by state commissions in this country, may be called an indirect method of securing information as to the efficiency with which safeguards to life and property are administered. To investigate signals and signal practice directly, without regard to accidents, would be a more direct method of promoting safety. Accidents should be investigated, for they increase so rapidly year after year that the record is looked upon as a reproach upon our American system of railroad management; but it is even more logical and reasonable to investigate signal practice, for, as regards the worst class of accidents, namely, collisions, investigation and regulation which look to prevention are chiefly of value. Investigation to this end is needed under four heads, namely:

(1) The telegraph block system on the larger roads (mainly double track) as regards the personnel and the routine; the use or non-use of distant signals, and the practice of permissive block signaling.

(2) The telegraph block system on single-track lines and minor roads, as regards the personnel, the routine, distant signals and permissive signaling, and also as regards the use of time rules and despatchers' orders to make up for incompleteness in the block signaling arrangements.

(3) The automatic block system should be investigated on all roads with respect to the efficiency of the apparatus and of the methods of inspection and care, and the integrity of the records of signal operations in respect to their completeness.

(4) The automatic block system on single-track lines should be investigated with respect to the features named in the foregoing paragraph, and also as regards the use simultaneously with the block signals of despatchers' orders and other measures designed to prevent collisions irrespective of the block signal system.

"If the legislative enactment should not require the early introduction of the block system on all railroads, government inquiry should be pursued with a view to determine the necessity for its installation on particular lines or parts of lines on which it is not now in use. The principal and, indeed, the only argument against the enactment of a compulsory block signal law is that a large number of railroads are now making fair progress in the extension of block signals without compulsion. Certainly the roads which come within this class can have no fault to find with such a mild measure of compulsion as that provided for in the bill proposed by the commission; while as to roads which have taken no action, some compulsion should be employed to require them to bring their service up to a proper standard within a reasonable time.

"The question of the need of apparatus for automatic control of trains is a somewhat difficult one. Collisions occur occasionally under both the telegraph and automatic block systems, which an efficient automatic stopping apparatus might prevent. The locomotive engineman has most exacting duties. An individual runner may be far above the average in mental poise and moral character and yet may fail in vigilance or in judgment occasionally, and such failure may mean disaster. Again, the individual engineman may be efficient in a high degree, and yet the efficiency of a force of enginemen as a whole may be unsatisfactory. The engineer performs such an innumerable succession of important acts on every trip that, even with an infinitesimal percentage of failures, the 40,000 or 50,000 engineers of the United States may still be chargeable in the course of a year with a large aggregate of fatal and non-fatal injuries. Anything less than perfection is

cause, at least, for investigation, if not for decided dissatisfaction. Every great accident due to an engineman's fault is followed by a strong public demand for the introduction of automatic train stopping devices. As previously shown in this report, such devices used to a limited extent, though not on interstate roads, seem to have given a fairly good account of themselves; but these records do not justify the commission in making any recommendation as to their use or non-use without a more thorough and complete investigation.

"The limited extent to which devices of this character have been used makes it practically impossible for the commission to obtain anything more than theoretical and technical knowledge concerning them. It is therefore apparent to the commission that Congress cannot be furnished with much further information concerning these appliances, which would appear (to be) extremely valuable, theoretically, without extensive tests conducted by officials of the government and at government expense. For this reason and because the resolution under which this inquiry has been made does not confer authority to make such tests, the commission, on January 3, 1907, addressed a communication to Congress recommending that supplemental legislation be enacted authorizing the commission or some other official body to supervise and conduct experimental tests of such safety devices as appear to be meritorious, and that an appropriation be made sufficient to secure the most competent experts and defray the other expenses incident to such a project. The commission can only repeat this recommendation, believing that such experimental tests would be of great value in determining the direction which legislation not now recommended should take in seeking to add to the safety of railroad operations.

"The recommendations of the commission for immediate or early legislation are summarized as follows:

(1) That the use of the block system should be enforced on the passenger lines of the country, and that the time to be allowed for final compliance with its compulsory features should be made three or four years from the present.

(2) That with or without the passage of a law requiring the use of block signals, there should be a law authorizing an official investigation of train accidents, and providing for the employment of competent men to perform the duties imposed by such an enactment.

(3) That investigation by official tests of automatic appliances for the control of railroad trains should be authorized in accordance with the commission's recommendation of January 3, 1907, with an appropriation of sufficient amount to conduct such tests in a proper manner."

A LOW-SPEED HEAVY TRACTION ENGINE.

A STEAM-DRIVEN TRUCK USED IN GERMANY FOR HAULING HEAVY WAGONS.

H. Heller—Zeitschrift des Vereines Deutscher Ingenieure.

THE use of traction engines on public highways has been much more general in Great Britain and Europe than in the United States, and such a machine, before the common use of motor cars, was rather rare; but with better roads than are at present available, and a more careful consideration of the cost of hauling merchandise, there may be, in the future, a demand for a simple, powerful motor car, built to haul one or more loaded wagons. An article in a recent issue of the *Zeitschrift des Vereines Deutscher Ingenieure,* describes a traction engine for use on ordinary highways in Germany. The engine is heavy, and very substantially built; and on a good road, should give very economical results based on ton-mileage.

It is a four-wheeled vehicle made up of two parts, each carried by an axle, the two being flexibly connected by a steel beam or reach. The surfaces of contact between the front and rear portions are shaped to arcs of circles and are provided with intermeshing teeth, so that the two articulated portions are kept in alignment with the center of the roadway, while adjusting themselves as a whole to the curves. The effective wheel base of the machine is thus made quite small.

The forward half of the vehicle carries a Lavies water-tube boiler with 161.4 square feet of heating surface, which is fitted with a furnace for burning crude oil. The chauffeur occupies a roofed platform just back of the boiler. The steering wheel is mounted vertically, with the throttle and other fittings within convenient reach. The engine is located at the back of this platform. It is a double motor, consisting of two four-cylinder single-acting engines, each with cylinders 3⅜ inches in diameter and 3¼ inches stroke, taking steam at 220 lbs. pressure and developing 40 horse power at 800 revolutions per minute. Each engine drives one wheel of the forward part of the vehicle through double reduction gears and a chain drive. The steering wheel is connected, through bevel gears, to an inclined steering post, and the latter in turn, through another gear, transmits motion to a transverse screw shaft, threaded through a box or nut built into the reach of the vehicle. In this way, the change of direction of the parts is accomplished.

The rear half of the motor-wagon is a tender, carrying 528 gallons of water and 211 gallons of fuel oil. The weight is transmitted to the axles through half elliptic springs of massive construction. The whole engine is 25 feet long and 6 feet 10 inches wide, outside measurements, with a wheel base of 12 feet 10¾ inches. The driving wheels are 5 feet 11 inches in diameter and have tires 10 inches wide. The weight, which amounts to 8¼ tons on the forward axle and 5½ tons on the rear, is so distributed that it ought not to damage a well-built road to any extent.

This engine is intended to haul two trailers, which are built on the same principle as the motor vehicle. Each trailer consists of two articulated single-axle vehicles, jointed in the middle and secured together by a steel beam pivoted at its ends over each axle. Couplings are made by means of a spring draw bar with short link and pin coupling. Each vehicle is equipped with a powerful brake operated by a handwheel. The engine can haul, on a level road, a load of 17½ tons in the two trailers at a speed of 4.3 miles per hour.

It is doubtful whether such wagon trains will ever become common in the United States. Certainly their excessive length might be an objection to their use, particularly in cities and towns, since the engine and two vehicles have a total length of 72 feet 2 inches. When the rights of the public are taken into consideration, the use of many such trains would approach a monopoly of the road, and seriously raise the question of overstepping the limits of allowable space for private advantage.

TESTS OF CONCRETE: SHEAR, AND BOND OF STEEL.

A SUMMARY OF TESTS RECENTLY CONCLUDED AT THE UNIVERSITY OF ILLINOIS.

Bulletin of the Engineering Experiment Station.

THE latest bulletin of the Engineering Experiment Station of the University of Illinois reports the results of a series of tests, extending over a period of two years, on the shearing strength of concrete and the strength of the bond between concrete and steel. Notwithstanding the very extensive use of reinforced concrete as a building material, but little exact data as to its properties is available, and the information contained in this report is an important contribution to the literature of the subject. The general conclusions drawn from the tests, as summarized in the report, are given below.

It was found very hard to devise a method of testing concrete in shear so as to avoid the possibility of its failure either by crushing or in tension. Two methods of testing were finally decided upon after an exhaustive study had been made of all previous investigations on the subject. In the first, "the punching test," a hole was punched in a concrete plate or block. The second method, "the restrained beam test," consisted in breaking a short concrete beam which was restrained at the ends.

The punching tests were performed on blocks 13 inches square. Three forms of test piece were used: a plain concrete block 3 inches deep; a recessed concrete block 5 inches deep with a circular space 7 inches in diameter and 2 inches deep hollowed from the bottom; and a block similar to

the latter but reinforced, just above the recess, by horizontal rods placed near the perimeter of the piece. In making the tests, the specimen was placed on a bed plate 1 inch thick, with an opening 6 inches in diameter in the centre. The load was applied through a spherical bearing block and a die 5⅞ inches in diameter formed the punching tool.

The test piece for the restrained beam test was 13 inches long and 4 inches square in cross section. It was bolted securely to bed plates above and below, with a 4⅛ inch opening between end reactions. The fracture was caused by the pressure of a 4 inch plate immediately over the opening in the bed plates.

The following are the general conclusions reached by the investigators.

"It is difficult to devise a form of test specimen and a method of testing which will satisfactorily determine the resistance of concrete to shear. The difficulties lie in the inability to secure an even distribution of the shear over the shear section, in the high cutting and bearing stresses developed, and in the complications formed by the compressive, tensile, and bulging and bursting stresses developed. The forms of test specimen here used are not fully satisfactory, but information concerning the shearing resistance of concrete may be drawn from the tests as a whole, and tentative values selected. A test specimen in the form of a beam and in which the load is applied evenly over the depth of the beam instead of on the top is suggested.

"The resistance of concrete to shear is dependent upon the strength of the stone as well as upon the strength of the mortar, and for the richer mixtures the strength of the stone probably exercises the greater influence. With hard limestone and 1:3:6 concrete 60 days old the shearing strength may be expected to reach 1,100 pounds per square inch, and with the 1:2:4 mixture 1,300 pounds per square inch. It seems very probable that the resistance to simple shear is considerably higher than this, and that tests made with the load applied evenly over the shearing section will verify this.

"Since the compressive strength of concrete is influenced largely by the strength of the cement and the shearing strength is much more influenced by the strength of the aggregate, it does not seem proper to express the shearing strength in terms of the compressive strength. However, this is frequently done and is of advantage in gaining a conception of their relative action. It appears that the shearing strength is, in general, at least 50 per cent. of the compressive strength, and that it may exceed 75 per cent. The apparent exception to this is explained by the high values obtained in the 1906 compression tests. These conclusions agree in a general way with the statement of other investigators that the shearing strength is as much as two-thirds of the compressive strength. Evidently the shearing strength of concrete is several times its tensile strength."

In the tests of the bond between concrete and steel, both plain rolled steel bars and smooth finished bars or shafting were used. The following summary of the results is given in the report.

"Little difference is found in the bond resistance per square inch of surface of bar in contact with the concrete whether the bar is embedded 6 inches or 12 inches. Evidently a length may be found beyond which the stretch of the steel would cause uneven distribution of the bond stress along the depth of the bar and cause failure to begin at the point of greatest stress in the steel and thus give results not representative of the real bond resistance. This limitation applies to length for use in experimental tests of bond. In simple beams the bond stresses are applied along the length of the bar, and stretch and bond exist together.

"The richer mixture of concrete gives somewhat higher bond resistance than the leaner: the values for the 1:2:4 concrete averaging 10 per cent. to 15 per cent. higher than for the 1:3:5½ concrete. For plain round mild steel rods, the average for the bond resistance ranges from 350 to 450 pounds per square inch of contact surface.

"The flat bars gave much lower resistance than round bars, but only three tests were made with flat bars, and these may not be representative. It may be noted that the results with flat bars are much lower than tests made elsewhere. It should also be noted that for a bond stress of 125

pounds per square inch the tensile stress developed in the bar was only 9,000 pounds per square inch.

"The value of bond resistance will depend upon the smoothness of the surface of the bar, the uniformity of its diameter and section, the adhesive strength of the concrete, and the shrinkage grip developed in setting. The effect of smoothness of surface and uniformity of diameter and section is seen in the tests made with cold rolled shafting and tool steel. The average bond developed with these was 147 pounds per square inch of contact surface, as compared with about 400 pounds per square inch for ordinary plain, round, mild steel rods. Not only was there a very noticeable difference in the smoothness and finish of the surface of the rods, but the section of the cold rolled shafting and tool steel was very uniform, the diameter not varying more than 0.0001 or 0.0002-inch at ¼-inch intervals throughout the length, while mild steel rods will vary as much as 0.0015 inch. It is to be expected that the smoothness and uniformitv of section of drawn steel wire will operate to give low values of bond resistance, though, of course, as the section of wire is small compared with the circumference, the bond stresses developed when wire is used are relatively small. In reinforced concrete beams the bond stresses developed in beams failing by tension of the steel, diagonal tension of the concrete or other similar methods, amounted to from 73 to 193 pounds per square inch. Even at the breaking load, then, the bond stress developed in the mild steel rods was far below the bond resistance found in these tests.

"The bars began to slip when the maximum load was reached. After slipping began, the resistance to motion was still considerable. This running friction, taken when the bar had moved about ¼-inch, amounted to 54 per cent. to 72 per cent. of the bond developed in the case of mild steel bars, and to 32 per cent. to 49 per cent. in the case of the cold rolled shafting."

RECENT FAILURES OF REINFORCED CONCRETE.

A DISCUSSION OF SOME OF THE PRESENT FEATURES OF THE REINFORCED-CONCRETE INDUSTRY AND THE EFFECT OF FAILURES UPON IT.

Louis H. Gibson—Municipal Engineering.

WITHIN the past few months, two notable reinforced-concrete structures in the United States have collapsed during construction, the one the Hotel Bixby at Long Beach, Cal., and the other a structure for the Kodak Company at Rochester, N. Y. These two failures have attracted considerable attention and have been widely noticed in the technical press. In a paper recently published in *Municipal Engineering*, Mr. Louis H. Gibson comments on their causes and offers some timely criticism on the methods and principles of the promoters of the reinforced-concrete business generally.

The evidence with regard to the disaster at Long Beach is not conclusive. The finding of the coroner's jury was that the failure was due to the too early removal of the forms under the roof slabs; an independent investigator states that the design, construction, and materials were all faulty. Fuller evidence is available, however, in the case of the failure of the Kodak Building and the record is of such a character as to justify the expression of an opinion. The finding in this case was that the design was faulty; that all the metal indicated in the drawings was not installed and the installation of what metal was put in was carried out in an imperfect manner; and finally, that the concrete was generally bad, in some cases contained sawdust, leaves, and other foreign material, was improperly mixed, and was not always perfectly tamped. Mr. Gibson considers the knowledge and ability of the contractors for this structure to have been unquestionably sufficient to design and construct a building that would stand up and attributes their failure to use proper materials and proper care in construction to some fault in organization.

"These disasters do not discredit the general idea of reinforced concrete. They do not discredit the particular system or the

kind of metal or the shape of the bars used. These happenings should in all justice have no ill effect upon the general idea of reinforced concrete or any part of the system, as such, that was employed on these buildings. These disasters will have no evil effect upon the mind of any one who carefully examines these structures or who carefully studies full and intelligent reports in regard thereto. The more carefully these structures are examined and considered as a system, the more friends will they make for the reinforced-concrete idea. Careful consideration, analysis and examination of the buildings themselves will supply abundant reasons for their failure without reflecting upon the general reinforced-concrete idea. Had these buildings been constructed on any other system the verdict of public opinion would not have been against the system, or the general principle or idea involved in the building, but would have been against merely the designers and builders of the structure. This is where the responsibility really belongs now and this is where in all fairness it should be placed. . . . . .

"One can not say that these disasters will not result in some immediate loss to reinforced-concrete buildings generally, but one may well question the ultimate loss. If they should serve to make contractors and builders more thorough, which now seems more than probable, it is reasonable to believe that the ultimate result will be beneficial to the efficient and high-minded builder. Nevertheless, the contractors for this work which has failed have cut out a large amount of unnecessary work for themselves and everybody else interested in special cement construction. . . . . .

"The spirit of promotion on the part of many engaged in the reinforced-concrete business has had a baneful influence on the engineering side of the work. On this account the work has suffered. This spirit of promotion has to some extent been of a hustling, bustling, hysterical character. It has been, in a way, successful in developing business, but it has not carried with it the spirit of high seriousness and thoroughness on the engineering and constructive side of the work. Certain corporations and contractors have been top heavy on the sales side of their business and relatively indifferent to the constructive side of the undertaking. A business of this kind may be built up along engineering and constructive lines even though the sales side be measurably neglected. If the conditions be reversed we will see what we have seen and are now seeing in instances of failure which, if often repeated, will result in general discredit to the business. The value of the reinforced idea can be realized by conscientious constructive methods, but it cannot be realized when the major part of the effort is directed to the sales department.

"We can not create a business related to engineering construction, but we may develop it. One of the most successful companies engaged in this work has worked solely along the line of engineering, and they have specialized on this department and always sought to give their customers the very best of engineering and construction. The world at large has heard but very little from them, but those who are led their way find them with large works in hand and evidences of a safe and profitable business. They have developed their business along engineering and structural lines and the man who runs will say that they have neglected the sales department. . . . . .

"Architects and builders have always been friendly to cement in its various relations and especially so to reinforced concrete. The general idea of reinforced construction in itself is interesting and so fascinating, in fact, that it at once secured a sentimental as well as a practical interest. The dominant reason, however, was practical, in that the cost was relatively low as compared with structural steel and clay fireproofing. This feature, especially, attracted capitalists to it. The Baltimore and San Francisco fires and other smaller conflagrations attracted favorable attention to concrete construction. The low structural and maintenance cost commended it especially to the builders of bridges and other engineering work. Thus, taking it all in all, no structural medium has ever come so rapidly and conspicuously into favor as reinforced concrete.

"The enthusiastic, general and hearty reception of this system has had a baneful effect on the character of the work done.

The readiness with which the building public has taken up with the reinforced-concrete idea has led many, who are temperamently unsuited to engineering and structural work, to organize companies and to dominate the policy of certain establishments. Now, it is not every promoter who can successfully manage any business and it is certainly true that the promoter's temperament and that of the engineer do not always belong under the same roof. This question of temperament is not thougnt of in this connection as related broadly to the question of integrity or honor. There is, nevertheless, a difference in the quality or variety of honor required in different occupations. The honor of the engineer is different and his temperament different from those of the banker or the business man. They carry a certain large measure of pride or sentiment and at times a disregard of profit for profit's sake, which do not fit into the qualities of the notably successful business man. It is true, however, that one may succeed in business merely because he is a good engineer, but no one is apt to succeed as an engineer merely because he is a business man."

LOCOMOTIVE FEED-WATER HEATERS.

A SYSTEM OF FEED-WATER HEATING APPLIED TO LOCOMOTIVES ON THE EGYPTIAN STATE RAILWAYS.

E. Sauer—Zeitschrift des Vereines Deutscher Ingenieure.

ALTHOUGH feed-water heaters have been tried in locomotive service in the United States, they have never come into general use, as the possible saving to be effected by their use is not great enough to offset their probable maintenance cost on account of repairs and loss of time in the shop. The locomotive-building firm of Henschel & Son, of Cassel, Germany, however, has applied one of these devices to a passenger engine recently built for the Egyptian State railways which seems to have given good results in fuel economy.

The locomotive is of the 4-4-0, or eight-wheel type, with cylinders 18 by 26 inches, boiler pressure 185 lbs. per square inch and driving wheels 6 feet 3 inches in diameter. It has a straight top boiler, with a grate area of 23.7 square feet and a total heating surface of 1,227 square feet. Its weight, in working order, is 123,000 lbs. The feed-water heating system consists of four principal parts in series, through each one of which the water is forced by a pump on its way to the boiler. A duplex pump, mounted on the running board on the right-hand side of the locomotive draws water from the tender tank and forces it into the first part of the heater, which consists of a vertical cylinder located between the driving wheels on the same side as the pump. The pump exhausts into a nest of tubes inside the cylinder, thus imparting the latent heat of the exhaust steam to the feed water circulating around the tubes. After being warmed in this first stage, the water is forced through a delivery pipe to another heater located just over the forward truck, in the usual place of the cylinders, this locomotive being inside connected, with the cylinders between the frames. From the second stage of the heater the water is forced to the third stage, an exactly similar cylinder located on the opposite, or left-hand side of the engine. These two parts of the apparatus are heated by the exhaust steam from the main steam chests, the exhaust being piped through them on its way to the stack. As only a portion of the exhaust steam is obliged to take this path, the back pressure on the exhaust side of the pistons is not increased to an appreciable extent. The feed water, after leaving the third part of the heater, next passes into a ring-shaped sheet metal chamber inside the smokebox and concentric with it. Inside this chamber is a nest of 265 tubes ¾ inch in diameter, placed longitudinally or parallel to the axis of the boiler, through which the water passes before being delivered to the check valve. A further accession of heat is given to the water as it goes through these tubes from the smoke and gases, which after entering the smokebox, pass forward through the ring-shaped chamber, and then back to the stack.

This arrangement is a complicated one, and the second and third heaters could be applied only to an inside-connected engine. It is difficult to see just where they could be placed when the cylinders are outside, as each cylinder is 6 feet 3 inches long and 15 inches in diameter. Furthermore, the nests of tubes in the four separate parts of the heater would be very likely to give trouble by leaking, and at best, their maintenance cost must be an item of considerable importance. It is found in service tests that with water in the tender tank at a temperature of from 70 degrees to 80 degrees F., the water can be delivered to the boiler at a temperature of about 250 degrees F.

A series of tests conducted with this locomotive in competition with one without a feed-water heater under similar conditions of service between Cairo and Alexandria, showed a saving of coal of 21.4 per cent. in favor of the former. The distance between the two cities, 129 miles, was covered by express trains in 3 hours 5 minutes, and the average weight of the trains during the test was 240 tons. The feed-water heater is said to cost, complete, $1,250, and the author of the article from which this description is abstracted states that the cost of coal at Alexandria was $5.38 per ton. Allowing 15 per cent. for depreciation of the heater, its annual cost becomes $187.50. The locomotives make an annual mileage of about 93,000 miles, and the author calculates from the results of the tests, a yearly saving of 274 tons of coal, amounting to $1,474. Deducting the annual charge for depreciation of the heater, there remains a yearly balance to its credit of about $1,286, an amount that would go a long way toward paying for the ordinary locomotive repairs. It is doubtful, however, whether the annual cost allowance of $187.50 would cover the whole cost of extra supervision and inspection, loss of time of the engine while in the shop, and delays on the road that would be entailed by the use of feed-water heaters on American railroads.

MARINE GAS PROPULSION.

THE DIFFICULTIES IN THE WAY OF APPLYING THE GAS ENGINE TO THE PROPULSION OF LARGE SHIPS AND A POSSIBLE SOLUTION.

A. Vennell Coster—Manchester Association of Engineers.

LAST month we reviewed in these pages an article dealing with the possibilities of the internal-combustion engine for marine purposes which considered only the mechanism and arrangement of the engine. A paper on the same subject, by Mr. A. Vennell Coster, recently read before the Manchester Association of Engineers, contains a discussion of fuels and gas producers and suggests an arrangement of engines which differs widely from that proposed in the former article. A few extracts are taken from Mr. Coster's paper with a view to showing how he proposes to solve the difficulties in the way of applying the gas engine to the propulsion of large ships.

"I feel confident that if a marine engineer were told that, by the introduction of the gas installation, he would obtain the following advantages, he would be more than satisfied with the substitution of gas for steam power.

(1) The ship driven with half the amount of fuel.

(2) Stand-by losses reduced over 75 per cent.

(3) Working pressure confined to the engine cylinders.

(4) No boiler tubes or main steam pipes to burst, or furnace crowns to collapse.

(5) No priming in a heavy sea way, or water hammer in pipes and cylinders.

(6) No more difficulties with the firing of boilers in a beam sea. Gas producers may be charged only twice every 24 hours, and the rolling and pitching of the vessel is rather an advantage than otherwise in assisting the fuel down from the charging hoppers.

"Firms of the standing of Messrs. Beardmore, Thornycroft, Yarrow, Crossley Bros., Nobel Bros., Sulzer Bros., Mr. H. Cherry and many others have already applied themselves to this venture, and the results so

far have been by no means discouraging. There are still many difficulties to be faced and overcome, but they will be overcome. In this paper my proposal is to put before you such a scheme of marine gas propulsion, that the most cautious of us would be willing to risk a voyage by its means. What are the main difficulties?

1st. The construction of a gas producer able to gasify all grades of bituminous coal.

2nd. A simple method to cleanse the gas from tar, either before the introduction of the fuel into the producer proper; when in the producer; or after the gas has left the producer on its way to the engine.

3rd. Perfect control of the gas propelled vessel in starting, stopping, reversing and running at all speeds.

These are the three main difficulties in our way.

"Dealing with No. 1 and No. 2. If anthracite coal or coke is used these difficulties are entirely avoided, but with a limited supply of anthracite our wisest course is to leave it out of the question altogether. For marine purposes we must deal with the ordinary coal that may be obtained, not only in Wales, but in various parts of the United Kingdom, and the many coalfields scattered about the world. Bituminous coal is cheap compared with either anthracite or coke, and as I have already stated, it is the only possible fuel for marine gas producers. Its thermal value varies from 10,000 to 14,000 British thermal units per pound, and costs from 6/- to 7/- per ton. For many years gas engines have been driven by bituminous coal gas, and the difficulty has always been to get rid of the condensible hydro-carbons which would fill and clog the valves and gas passages of any engine they were allowed to enter. This problem is one that must be faced rather by our chemists than by our engineers, and many notable firms have already solved the problem, but not in that simple manner that would make the gas plant perfectly suitable for marine purposes. It is reported from several trustworthy sources that a simple solution has been discovered.

"Then there is the necessity of dealing with the many grades of bituminous coal, some suitable, many unsuitable. Shipowners would have to insist on a correct analysis being supplied prior to delivery, so as to ensure gas producing qualities.

"The third difficulty, namely:—Perfect control of a gas propelled vessel is our next consideration.

"One of the main difficulties that confronts the gas engineer in applying gas engines for marine purposes is that of reversing. With small powers it is possible to reverse by means of a reversible propeller, the engine having only one direction of rotation. There is naturally a very serious objection to putting the reversing gear in so inaccessible a position as in the propeller, but at the same time, there is undoubtedly a future for this type for river and coast work, if made simpler and more reliable. For higher powers up to say 500 horse-power units there is another system in vogue for reversing the propeller, namely—a reversing gear, which may be a combination of bevel or spur gear and friction clutches, is fitted somewhere on the propeller shaft within the vessel and in an accessible position. But for powers above 500 horse power the gas engines themselves must be made to reverse, for this dispenses with expensive and complicated clutches. There is no practical difficulty in reversing the gas engine, provided a sufficient reservoir of compressed air is at command.

"But the greatest of all difficulties in the application of gas engines for marine purposes, is the attainment of a sufficient range of mean effective pressures in the engine cylinders, so that like a steam engine, varying speeds, from full speed to dead slow, can be run without fear of stopping. We may reasonably assume that a maximum reduction of 60 per cent. of the mean pressure leads only to a reduction of 35 per cent. of the speed of rotation, or, if half the cylinders are cut out, the speed of revolution will be reduced by about 32 per cent. Then by reducing the mean pressure in the remaining cylinders, the result will be a reduction of the effective turning effort to 25 per cent. of that of full power, the speed of revolution will be something less than half that of full power. This reduction of speed is not satisfactory for marine purposes and it is doubtful whether gas engines could be run with so great a reduction of explosive charge. As an example, the marine gas engine in the 'Lord Antrim' (mentioned below), with normal

speed of 150 revolutions, cannot safely be reduced below 75 revolutions per minute, because with a light fly-wheel and possible miss-fires, the engine has not sufficient momentum to carry it over the compression strokes.

"The following solution at once meets all these difficulties, whether the vessel has to run full speed or dead slow, by a practical manipulation of the speeds of independent engine units. In running some of them ahead and some of them astern any speed in either direction can be readily attained by the officer in charge of the vessel on the bridge, and without stopping, except during reversal, a single engine or the normal flow of gas through the gas producers.

"By this means the author attempts a solution (analogous to the turbine problem), but on different lines from those apparently adopted by builders of marine gas engines of 500 horse power and over. They rely on a large reservoir of compressed air for manoeuvering and working the vessel up dock, in narrow waters, or when running dead slow in foggy weather, because with one engine unit, as has already been stated, the vessel cannot be driven by gas much below half speed. But to depend on compressed air at these times, when engines and producers should prove not their inefficiency but efficiency, is to stultify the whole subject of marine gas propulsion."

Mr. Coster illustrates his solution by means of a concrete example. He takes the "Lord Antrim," a vessel 375 feet long by 47 feet beam and 28 feet depth. It is at present run by one triple compound engine, running 67 revolutions per minute and developing 2,360 indicated horse power. For this engine Mr. Coster proposes to substitute three gas engines developing the same horse power as the steam engine, but running at the increased speed of 150 revolutions per minute, the gas being supplied by four producers with their auxiliary apparatus, these producers having sufficient capacity to supply, besides the main engines, several smaller units for the driving of dynamos, electricity being used to drive the air-compressing apparatus, the pumps and other necessary machinery.

Each of the main engines runs a separate propeller shaft. "The central shaft is fitted with a larger propeller than the two wing shafts. These have two propellers carried on A frames from the bilge of the vessel, and do not project beyond the lines of the vessel, and are thus satisfactorily protected. It is possible, as already intimated, with this arrangement of machinery, to run the vessel at any speed from full speed to dead slow either ahead or astern, without stopping the engines except for reversing. For example: taking the propeller going astern as having only 50 per cent. efficiency when compared with going ahead, by running the centre engine full speed ahead, and the wing propellers about full speed astern, the vessel can be practically stationary. Then by slowing down the wing propellers to half speed astern, the vessel can be made to move about quarter speed ahead, and as these engines can vary their speed from 150 revolutions down to 75 revolutions per minute, any speed in any direction can be attained by the vessel without stopping the engines. In narrow waters, entering or leaving port, or working up dock, the vessel is under as complete control as if fitted with the latest steam engines, and with no fear of the quality of gas being reduced. With such an installation, which occupies somewhat less space, less weight, and about the same cost as a steam installation, but with about 50 per cent. less coal consumption, who would fear a deep-sea voyage if the machinery were in charge of experienced and capable marine gas engineers?

"There is no question in my mind as to what type of gas engine we should adopt for marine purposes, the simplest is the best, and there is no type so simple and satisfactory as the four-cycle or 'Otto' type, with its sequence of suction, compression, power, and exhaust strokes, taking place in each cylinder. This type of engine, with inverted vertical cylinders, has a mechanical efficiency of over 90 per cent. and a thermal efficiency of 33 per cent., and for a vessel requiring say 3,000 horse power units of six single-acting cylinders, with pistons of say 21-inch diameter by 24-inch stroke, would be suitable. But where larger powers are required, then tandem cylinder engines with open cylinder liners, having piston-rod and stuffing box between the tandem cylinders, where they can be easily inspected and adjusted, would be required."

CAR SHORTAGE.

A STATEMENT OF WHAT THE RAILROADS HAVE DONE TO RELIEVE THE SITUATION.

Arthur Hale—The Railway Age.

THE present shortage of freight cars is more general over the United States than any other the railroads have ever experienced notwithstanding the fact that it was foreseen. In 1906, the railroads ordered and obtained more freight cars than in any previous year, but the shortage still continues, and complaints seem to be as numerous and as general as ever. The blame has been placed upon the railroads and shippers equally, and the technical press has contained many suggestions as to how the situation might be relieved. Mr. Arthur Hale, writing in a recent number of the *Railway Age,* summarizes the efforts of the railroads to increase their facilities:

"If every railroad and every shipper or consignee handles the question solely from his personal point of view there will be no improvement of the present situation until it wears itself out; but there is an opportunity for great improvement if the railroads, the shippers and the consignees can each subordinate their desire for immediate individual gain and economy for the benefit of the whole country. I am, of course, more familiar with what the railroads can and ought to do than I am with what the shippers and consignees can and ought to do; and while I claim nothing particularly altruistic on the part of the railroads, I feel that I ought to call attention to the fact that besides the large additions to car equipment which I speak about, besides the large orders for cars which are not filled —and I think I am correct in my belief that the railroads will add another quarter million of cars to their equipment in 1907—the railroads have increased the wages of their employes by a very considerable amount this past year, thereby avoiding impending danger of general labor troubles. Furthermore, they have endeavored to add to their own and others' efficiencies by increasing the rates they pay each other for the use of cars. In the year 1905 the railroads were paying for the use of each other's cars the very small sum of 20 cents per day. It is true that this sum was charged for every day in the year, without allowances of any free time for loading, unloading, Sundays or holidays, and it is true that if any railroad delayed a car of another it could be made to pay $1.00 per day instead of 20 cents; but it was felt that 20 cents was not enough, and therefore on July 1, 1906, the rate was raised to 25 cents a day, or 25 per cent. As this has proved to be not enough to move the cars, a very considerable number of railroads entered into a further agreement, which took effect December 1, 1906, under which they are now paying each other 50 cents per day for the use of cars; and the roads in this agreement control nearly three-fourths of the cars in the country. Of course, many roads are directly benefited by this increase in the rate, but wherever one railroad gains another must lose, and to my mind the position of the railroads who have voluntarily doubled their expense for the use of others' cars is really public-spirited. These roads felt that a general increase in the rate of car hire between railroads would result in quicker movement of the cars and an improvement in the car supply; and despite an almost inevitable money loss to themselves, they entered into this agreement simply to improve the general situation.

"Another step intended to improve the general situation, and one which involves a very considerable expense, is the establishment of the American Railway Clearing House at Chicago by quite a number of railroads. This clearing house is to keep track of cars of the subscribing railroads on foreign lines, and will be in a position to locate such equipment, strike car balances and indicate a proper distribution of cars between all the railroads. I do not speak of various improvements in facilities which the railroads have made, involving improvements of their lines, sidings and terminals at very consderable expense. It is safe to say that wherever need has been demonstrated for facilities of this kind they have been added when the necessary capital can be secured.

THE ENGINEERING INDEX

THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE

The following pages form a descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full title of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX

CIVIL ENGINEERING 125
ELECTRICAL ENGINEERING 132
INDUSTRIAL ECONOMY 137
MARINE AND NAVAL ENGINEERING..... 138
MECHANICAL ENGINEERING 139
MINING AND METALLURGY..... 147
RAILWAY ENGINEERING 153
STREET AND ELECTRIC RAILWAYS..... 156

CIVIL ENGINEERING

BRIDGES.

Bearings.

Bearings for King Edward VII. Bridge, Newcastle-on-Tyne. Illustrations and particulars regarding the method of allowing for the expansion and contraction of the girders. 500 w. Engr, Lond—Jan. 25, 1907. No. 82157 A.

Bronx.

The Bronx River Bridge at East 233d St., New York. Illustrates and describes improvements including a steel structure over the four track of the New York & Harlem R. R., a concrete arch over the Bronx River, and masonry retaining walls. The river crossing is an elliptical concrete arch with interesting features. 600 w. Eng Rec—Feb. 23, 1907. No. 82526.

Drawbridge.

Drawbridge over the North Sea Canal, Amsterdam (Die Nieuwe Hembrug over

We supply copies of these articles. See page 158.

het Noordzeekanaal en de daarmede in verband staande omlegging van den spoorweg Helder-Amsterdam). H. N. Francois. Description of a 455 ft. draw span over a ship canal. Illus. 5900 w. De Ingenieur—Jan. 5, 1907. No. 82336 D.

Failures.

Some Bridge Failures During a Heavy Cyclone in 1905, in Gujerat, India. Andrew Thomas. An account of the extensive damages due to an unusual flood, and the rapid construction of temporary bridges. Plate. 2000 w. Inst of Civ Engrs—No. 3633. No. 82041 N.

Newark, N. J.

The Jefferson St. Bridge, Newark, N. J. Illustrated description of a skew double-track, riveted, through-truss structure carrying the main line of the Central R. R. of New Jersey. 1800 w. Eng Rec—Feb. 16, 1907. No. 82416.

New York City.

Cost of the Brooklyn Anchorage of the Williamsburg Bridge, New York City. Francis L. Pruyn. Gives general plan and elevations, with details of cost. 2500 w. Engng-Con—Jan. 30, 1907. No. 82174.

Plate-Girders.

Web Stresses in Plate Girders. W. E. Lilly. Describes experiments undertaken to study the effect of various dispositions of stiffeners on the deformation of the web of the plate-girder. Ills. 4000 w. Engng—Feb. 1, 1907. No. 82253 A.

Quebec.

Handling Eyebars at the Quebec Bridge. Illustrated description of the methods used in handling the large eyebars in this cantilever bridge. 2500 w. Eng Rec—Feb. 9, 1907. No. 82225.

The Traveler for the Erection of the Quebec Bridge. Illustrates and describes a traveler of the gantry type, much the largest ever built. 2500 w. Eng Rec—Feb. 23, 1907. No. 82521.

Reconstruction.

Strengthening the Three-Hinged Arch Bridge Over the Mississippi River Between Minneapolis and St. Paul, Minn. Frank H. Constant. Drawing, illustration, and description of the reconstruction of this highway bridge to strengthen it to accommodate interurban cars on double track 4500 w. Eng News—Feb. 14, 1907. No. 82290.

Reinforced Concrete.

The Factory Street Bridge in Canal Dover, Ohio. Edw. Stingel. Illustrated detailed description of a four-span arched reinforced concrete bridge of the Thacher type, crossing the Tuscarawas River and the Ohio Canal. 1500 w. Eng Rec—Feb. 9, 1907. No. 82221.

Stone.

New Stone Bridge at Orleans. Illustrated description of a bridge consisting of 7 stone arches with clear openings of 144.4 ft., with particulars relating to the design and construction. 3000 w. Engr, Lond—Feb. 8, 1907. No. 82470 A.

Susquehanna.

New Lehigh Valley Bridge Over the Susquehanna River, Near Towanda, Pa. Philip H. De Witt. An account of the improvement in alinement and grades between Towanda and Wysox, with illustrated description of the new bridge of 14 spans of deck plate girders. 1200 w. R R Gaz—Feb. 8, 1907. No. 82200.

Viaducts.

Viaducts on the Guatemala Ry. at Rodeo and Station 1132. Illustrates and describes the special features of these viaducts. 1200 w. Eng Rec—Feb. 16, 1907. No. 82415.

The Erection of the Las Vacas Viaduct, Guatemala Railway. Drawings and description of methods used in erecting the steel work of the second tower, spans, etc. 2200 w. Eng Rec—Feb. 2, 1907. No. 82106.

Competitive Designs for a Reinforced-Concrete Viaduct in Milwaukee, Wis. Illustrated descriptions of two notable designs, for which prizes were awarded, for a long viaduct over the Menomonee Valley; one a Melan arch, the other a hooped-rib arch. 4000 w. Eng News—Feb. 14, 1907. No. 82293.

The First Prize Design for the Grand Ave. Viaduct, Milwaukee. States the requirements of the competitive designs and illustrates the first prize design for a concrete structure to carry Grand Ave. across the Menomonee Valley. 1200 w. Eng Rec—Feb. 9, 1907. No. 82223.

The Breydon Viaduct at Great Yarmouth. William Marriott and Theodore Graham Gribble. *Pro. Inst. of Civ. Engrs.* Illustrated detailed description of the construction of a steel viaduct of five spans over the estuary of the River Yare, called Breydon Water. 4500 w. Bul Int Ry Cong—Jan., 1907. No. 82546 E.

Washington, D. C.

The Connecticut Avenue Bridge, Washington, D. C. Illustrated description of the Portland cement concrete highway bridge carrying Connecticut Ave. across Rock Creek. The cost of this nearly completed structure is $800,000. 1600 w. Eng Rec—Feb. 16, 1907. No. 82411.

CONSTRUCTION.

Baths.

Swimming Pools. Jno. K. Allen. Considers the design and construction. Ills. 1200 w. Dom Engng—Feb. 16, 1907. Serial. 1st part. No. 82419.

Chimneys.

Chimney Construction. Illustrates and describes types of chimneys, discussing

their foundation, lining, stability, and minor details. 3500 w. Engr, U S A—Feb. 1, 1907. No. 82100 C.

Concrete.

Concrete in Construction. Address by Edward T. Cairus before the Insurance Society of New York. Considers various processes of making and utilizing the material, with observations on fire tests of reinforced-concrete beams. 7400 w. Ins Engng—Feb., 1907. No. 82618 C.

Culvert.

A Novel Engineering Achievement—Burying a River to a Depth of 120 Feet. Illustrated description of the work of culverting the Ouseburn River, at Newcastle-on-Tyne, and filling the valley, to improve the connection with Heaton. 1200 w. Sci Am Sup—Feb. 9, 1907. No. 82179.

Dams.

The Cataract Dam, Sydney, New South Wales. Illustrated description of this masonry and concrete dam, constructed to supplement the storage of water for the city of Sydney. The total storage capacity is 21,411,500,000 gallons. 2000 w. Engng—Feb. 1, 1907. No. 82257 A.

A Remarkable Dam at Dellwood Park, Ill. Howard S. Knowlton. Rather unusual dam and bridge construction of reinforced concrete is illustrated and described. 700 w. Eng Rec—Feb. 9, 1907. No. 82228.

A Résumê of the Charles River Basin Project. Robert E. Barrett. Describes the construction of a roadway dam, architecturally beautiful, between the cities of Boston and Cambridge, forming a fresh water basin. Gives many illustrations. 2200 w. Harvard Engng Jour—Jan., 1907. No. 82619 D.

Failures.

See Reinforced Concrete.

Fireproofing.

Fire Protection Engineering. George Velten Steeb. Indicates the results already accomplished, showing how the work is being carried on. General discussion. 5000 w. Jour Assn of Engng Socs—Jan., 1907. No. 82496 C.

Floors.

Calculation of Reinforced Concrete Floors (Beitrag zur Berechnung der Hauptunterzüge von Eisenbeton-Balkendecken). S. C. Drach. Mathematical analysis of the stresses in concrete floors, longitudinally and transversely strengthened. Diagrams. 500 w. Zeitschr d Oest Ing u Arch Vereines—Jan. 4, 1907. No. 82334 D.

Foundations.

Foundation Problems in New York City. C. M. Ripley. Illustrates and describes the use of the air lock in sinking caissons to bedrock, and how the collapse of neighboring buildings is prevented. 1700 w. Ir Age—Feb. 14, 1907. No. 82264.

The Foundations of the Singer Building Extension, New York. An illustrated article describing the foundations for the tower 63 ft. square and a total height of over 612 ft. above the curb. 2200 w. Eng Rec—Feb. 2, 1907. No. 82105.

Piles.

Methods and Cost of Driving Raymond Concrete Piles for a Building Foundation. Gives figures of cost computed from records obtained in constructing the pile foundations for a building in Salem, Mass. 1000 w. Engng-Con—Feb. 13, 1907. No. 82219.

Experience with Steel Sheet Piling in Hard Soils. From a paper by William G. Fargo, read before the Michigan Engng. Soc., giving the writer's experience with this material. 1700 w. Eng Rec—Feb. 16, 1902. No. 82413.

Reconstruction.

A Piece of Reconstruction Work at Stanford University. Charles B. Wing. Brief illustrated description of the method used to restore the arcade arches distorted by the earthquake at Stanford University, to their original position, and of replacing the broken stones. 700 w. Cal Jour of Tech—Jan., 1907. No. 82050.

Reinforced Concrete.

An Eight-Story Reinforced Concrete Printing Building. Illustrated description of the building for the Ketterlinus Lithographic Manufacturing Co., in Philadelphia. 1700 w. Eng Rec—Feb. 2, 1907. No. 82108.

The Design and Construction of a Reinforced Concrete Apartment House. H. G. Perring. General remarks on this material, with illustrated description of a structure in Philadelphia. Discussion. 5000 w. Pro Engrs' Club of Phila—Jan., 1907. No. 82550 D.

Recent Failures of Reinforced Concrete. Louis H. Gibson. Remarks on the recent disasters at Long Beach, Cal., and at Rochester, N. Y., and the general reinforced concrete business. 2500 w. Munic Engng—Feb., 1907. No. 82276 C.

The Lesson of a "Concrete-Steel" Floor Failure. Gives facts relating to the collapse of a floor in England, discussing the cause of the failure. Ills. 2500 w. Builder—Feb. 16, 1907. No. 82585 A.

Failure of a 176 Ft. Reinforced-Concrete Chimney at Louisville, Ky. D. R. Lyman. An illustrated account of the failure of the chimney of the Seelbach Hotel, and report of the condition of the material, and the circumstances. 900 w. Eng News—Feb. 7, 1907. No. 82188.

Roads.

Mixing Rocks for the Wearing Sur-

face of Macadam Roads. Notes from a report of the U. S. Office of Public Roads relating to the phenomena attending the decomposition of feldspars. 1800 w. Eng Rec—Feb. 23, 1907. No. 82525.

Shafts.

Sinking a Shaft with Steel and Concrete Lining in Soft Ground. W. E. Wagner. An interesting account of successful waterproofing under heavy pressure. The sinking of a shaft for a shot tower, at East Alton, Ill. 1800 w. Eng News—Feb. 21, 1907. No. 82530.

Sheet Metal.

How a Roofer Managed a Skylight Job. H. Tims Reilloch. The first of a series of illustrated articles on handling different kinds of sheet metal work. 1200 w. Met Work—Feb. 2, 1907. Serial. 1st part. No. 82056.

Stack.

Erecting an Extension to the Steel Smokestack of a Copper Smelting Plant. Drawings and information in regard to an interesting piece of work at Douglas, Ariz., where a new section of stack was erected on a framework, and moved onto the old stack. 900 w. Eng News—Feb. 7, 1907. No. 82189.

Tile.

Suggestions for Setting Tile. Karl Langenbeck. Suggestions for the tiling of walls and floors. Ills. 2500 w. Met Work—Feb. 16, 1907. No. 82297.

Tower.

The Steel Framework of the Metropolitan Tower. Illustrated detailed description of the steel work, for the tower of the Metropolitan Life Insurance Co.'s building in New York City. 3000 w. Eng Rec—Feb. 9, 1907. No. 82222.

Tunnels.

Method of Relining the Hodges' Pass Tunnel, Oregon Short Line Ry. An illustrated explanation of the methods of work adopted. 800 w. Engng Con—Feb. 20, 1907. No. 82477.

Methods and Cost of Constructing a Tunnel Through Clay by the Shield Method, Lawrence Ave. Intercepting Sewer, Chicago, Ill. 1800 w. Engng Con. —Feb. 6, 1907. No. 82160.

Waterproofing.

Waterproofing Concrete—The Elastic vs. the Rigid Method. Edw. W. De Knight. Considers the treating concrete to make it, in itself, impermeable and protecting concrete with something apart therefrom, to make it waterproof. 3300 w. Cement—Jan., 1907. No. 82279 C.

MATERIALS OF CONSTRUCTION.

Brick.

Strength of Brick and Brick Piers. James E. Howard. Read at convention of the Nat. Brick Mfrs. Assn. Gives results of tests made at the Watertown Arsenal. 2200 w. Eng Rec—Feb. 23, 1907. No. 82528.

Cement.

The Specific Gravity of Portland Cement. David Butler Butler. A report of results obtained by experimental investigations with a summary of the conclusions. 1000 w. Inst of Civ Engrs. Abstract of paper. No. 3625. No. 82035 N.

Solubility of Portland and Slag Cement (Ueber den Einfluss einiger Lösungen auf Portland und Schlackenzement). Heinrich Renezeder. Description of tests of mixtures of the two in different proportions. Ills. 1300 w. Oest Wochenschr f d Oeff Baudienst—Jan. 19, 1907. No. 82338 D.

Concrete.

Concrete Surface. Henry H. Quimby. Discusses tooling the surface, or the removal of the film and the exposure of the clean aggregate by any method, to give a pleasing surface. Also the effect of scrubbing the fresh surface with a brush and water. 2500 w. Cement—Jan., 1907. No. 82277 C.

Eucalyptus.

Eucalyptus as a Hardwood. O. M. Boyle, Jr. Information concerning this rapid growing timber and its value and uses. 3000 w. Cal Jour of Tech—Jan., 1907. No. 82051.

Gypsum.

Gypsum (Plaster of Paris) and Its Utilization. Trans. from Marco Pedrotti's "Der Gyps und Seine Verwendung." Gives early history of this material and the recent increase in the use. 2500 w. Sci Am Sup—Feb. 23, 1907. Serial. 1st part. No. 82578.

Iron and Steel.

On the Resistance of Iron and Steel to Reversals of Direct Stress. Thomas Ernest Stanton, and Leonard Bairstow. Describes experiments undertaken to ascertain the relative resistance of certain kinds of iron and steel in common use among engineers when subject to reversals of stress. Also investigations of the changes in structure of materials. Ills. Discussion. 2 plates. 19700 w. Inst of Civ Engrs—No. 3630. No. 82043 N.

Marbles.

I. Marbles: Their Ancient Application. Sir Lawrence Alma-Tadema. II. The Modern Aspect of Marble-Work in Architecture. William Brindley. Two papers, discussed together, and finely illustrated. 10000 w. Jour Roy Inst of Brit Archts. —Jan. 26, 1907. No. 82463 F.

Reinforced Concrete.

Economic Design of Reinforced Concrete. F. W. Hanna. Discusses the effect of the variable cost of steel and concrete on the economic working stress of

the steel and the corresponding percentage of reinforcement. 1200 w. Eng News. —Feb. 21, 1907. No. 82531.

The Influence of a Few Local Economical Considerations on the Design and Execution of Reinforced Concrete Work. Rudolph B. Hartman. An illustrated article considering structural features of reinforced concrete work, materials and methods, and information needed by an engineer using this material. 8000 w. Wis Engr—Feb., 1907. No. 82617 D.

Mechanics of Reinforced Concrete. Prof. W. K. Hatt. A discussion of this material and the mechanical principles underlying the construction. 1800 w. Cement age—Feb., 1907. No. 82495.

Tests of Shear and of the Bond of Steel in Reinforced Concrete. Prof. A. N. Talbot. Results of tests made at the University of Illinois, to determine the unit values of shear in concrete and the bond between steel and concrete. 3000 w. Eng News—Feb. 14, 1907. No. 82292.

Timber.

Steel versus Wood. A comparison of the prices of steel beams and Southern pine, showing that for heavy loads steel is the cheaper. 1100 w. Ir Age—Feb. 14, 1907. No. 82262.

The Line of Advance in Wood Preservation. Carl G. Crawford. Read at meeting of Wood Preservers' Assn. A review of what has been accomplished, and especially recent improvements in processes, and the future outlook. 3500 w. Eng News—Feb. 7, 1907. No. 82187.

MEASUREMENT.

Deformations.

A Universal Instrument for Measuring Deformations of Materials. H. F. Moore. Illustrates and describes a self-indicating apparatus adapted to a large range of tests. 1200 w. Wis Engr—Feb., 1907. No. 82616 D.

MUNICIPAL.

Asphalt Plants.

The Design and Construction of Two Asphalt Mixing Plants. Illustrates and describes plants at Cincinnati and at Pittsburg, which have features of interest. From a paper by Charles Brossmann, Jr., before the Indiana Engng. Soc. 1600 w. Eng Rec—Feb. 9, 1907. No. 82224.

Combined Plant.

Electricity and Destructor Works. A. J. Abraham. Remarks on the success of combined plants for small towns, and their failure usually for towns of 40,000 or more inhabitants. 2000 w. Elec Rev, Lond—Feb. 1, 1907. No. 82246 A.

Pavements.

Granite-Top Macadam Paving in Oak Park, Ill. R. A. Carpenter. Abstract of a paper read before the Ill. Soc. of Engrs. & Survs. Reports the use of this pavement, calling attention to points to be observed in its construction in order to obtain the best results. 900 w. Eng News—Feb. 14, 1907. No. 82291.

Sewage.

New Electrically-Driven Sewage Pumping Plant at Salem, Mass. Illustrated description of interesting features in the new system for disposing of the sewage. 2000 Eng Rec—Feb. 23, 1907. No. 82527.

The Sewage Purification Problems, with Special Reference to Sewage Discharge into a Tidal Estuary. James D. Williamson, M. D. Deals with conditions at Belfast, and cities similarly situated, discussing the effect of sewerage discharged into tidal waters. General discussion. 8800 w. Jour Roy San Inst—Feb., 1907. No. 82288 B.

Sewage Filters.

The Maintenance of Sewage Filters in Winter. George E. Bolling. Gives experience with furrowed beds in winter at Brockton, and other information relating to the working of these filter-beds. General discussion. 7500 w. Jour Assn of Engng Socs—Jan., 1907. No. 82498 C.

Sewers.

Methods and Cost of Constructing a Large Reinforced Concrete Sewer at St. Louis, Mo. An unusual piece of sewer work is illustrated and described. The methods of construction and the cost are given. 900 w. Engng-Con—Feb. 20, 1907. No. 82476.

Sewer Construction in Holland (De Rioleering van S. Gravenhage). F. C. J. Van Der Steen Van Ommeren. Ills. Serial. 2 parts. 14000 w. De Ingenieur—Dec. 8 and 15, 1906. No. 82314 each D.

Sidewalks.

Cement Sidewalk Paving. Albert Moyer. Suggestions for the work in order to secure permanency, durability and neatness. Also specifications. 4800 w. Cement—Jan., 1907. No. 82278 C.

WATER SUPPLY.

Berlin.

Water Supply of Berlin (Die Wasserversorgung Berlins). Herr Anklam. Description of the supply and distributing system. Ills. 4200 w. Gesundheits Ingenieur—Jan. 26, 1907. No. 82352 D.

Filtration.

Different Methods of Purifying Water. P. A. Maignen. Gives much valuable information concerning processes of filtration, and chemical treatment, with illustrations. Discussion follows. 20500 w. Pro Engrs' Club of Phila—Jan., 1907. No. 82547 D.

The Filtration-Works for Supplying the Town of Alexandria with Potable Water. Henry Robert Cecil Blagden. Describes

We supply copies of these articles. See page 158.

the first works of this kind in Egypt, this being the first town in Egypt to have an efficient filtration system. The Jewell system. 2 plates. Inst of Civ Engrs—No. 3615. No. 82038 N.

The Mechanical Filtration Plant at Wilmington, N. C. A. O. True. States the conditions of the water supply of this city, and gives an illustrated description of the filtration plant. 1800 w. Eng Rec—Feb. 9, 1907. No. 82226.

Theory of Artificial Biological Filters (Zur Theorie Künstlicher biologischer Filter). S. K. Dzierzgowsky. Tables, diagrams. Serial. 2 parts. 9300 w. Gesundheits Ingenieur—Jan. 5 and 12, 1907. No. 82306 each D.

Los Angeles.

Los Angeles Water Supply. Details of the proposed scheme to bring water 200 miles at a cost of over $24,400,000. Map. 2200 w. Engr, Lond—Feb. 8, 1907. No. 82471 A.

Marietta, Ga.

The Water-Works System and Electric Lighting Station at Marietta, Ga. Illustrated account of the reconstruction of the water-works system and electric power station to meet the increasing demands of service. 1800 w. Eng Rec—Feb. 23, 1907. No. 82522.

Sprinkler Systems.

Hazard of the Sprinkler Tank. J. E. Curtis. Discusses the erection and maintenance, the requirements for hoops, etc. 1500 w. Ins Engng—Jan., 1907. No. 82059 C.

The Care of Sprinkler Systems. Henry A. Fiske. Information concerning the proper maintenance of this protection, common faults that should be remedied, with suggestions relating to heads and valves. 4800 w. Ins Engng—Jan., 1907. No. 82058 C.

Stand-Pipe.

Reinforced Concrete Stand-Pipe at Attleboro, Mass. Illustrated detailed description of the construction of a structure 50 ft. in diameter and 106 ft. high. 2000 w. Eng News—Feb. 21, 1907. No. 82534.

Sterilization.

A Sterilized Water-Supply at Leavesden Asylum. William Thomas Hatch. Illustrates and describes the sterilizing apparatus, reporting tests made, coal consumed, and experiments in connection with the design of the apparatus. 3300 w. Inst of Civ Engrs—No. 3606. No. 82037 N.

Towers.

The Krestovsky Twin Water Towers at Moscow. Notes on the water system of Moscow, with illustrations of the twin towers and information of interest relating to them. 1200 w. Eng Rec—Feb. 2, 1907. No. 82107.

Wells.

Sinking a Flowing Well for the Water-Works of Salem, Va. J. N. Ambler. Describes the work of sinking, the difficulties and methods of overcoming them. 2500 w. Eng News—Feb. 7, 1907. No. 82186.

Sinking and Lining a 6-ft. Well 80-ft. Deep in Water-Bearing Soils. Information concerning work of excavating a well for a shot tower at East Alton, Ill., through sand, gravel and clay, which carried large quantities of water, and providing a perfectly waterproof concrete lining under very difficult conditions. 2000 w. Eng Rec—Feb. 16, 1907. No. 82414.

The Formation of a Concrete Well-Lining by Cement-Grouting Under Water. Robert William Vawdrey. Describes the method of carrying out this work, which illustrates one of the many uses to which Portland-cement grout may be applied. 2000 w. Inst of Civ Engrs—No. 3616. No. 82036 N.

WATERWAYS AND HARBORS.

Brussels.

Water Front Improvements at Brussels (Les Nouvelles Installations Du Port De Bruxelles). J. M. Roux. Description of bridges, canal improvements, etc. Ills. 4200 w. Le Génie Civil—Jan. 12, 1907. No. 82323 D.

Canals.

Mechanical Canal Locks in Canada. Walter J. Francis. An illustrated detailed description of the Canadian hydraulic locks on the Trent Canal. 7000 w. Can Soc of Civ Engrs—1906. No. 82053 N.

The Canal System of Canada. Maps and description of the canals through Canada from tidewater to the Great Lakes, and also the branches; calls attention to improvements needed to accommodate the large vessels, and the canals under construction to connect Lakes Huron and Ontario. 2200 w. R R Gaz—Feb. 15, 1907. No. 82404.

The Chesapeake and Delaware Canal. Lewis M. Haupt. An introductory statement of present conditions causing congestion of traffic, urging the improvement of waterways as a remedy, and giving arguments of the Trades League of Philadelphia in favor of the construction of the Chesapeake and Delaware Canal. Ills. 5000 w. Jour Fr Inst—Feb., 1907. No. 82060 D.

Colorado River.

Notes on Closing the Break in the Colorado River. Illustrates phases of this difficult work, giving explanatory notes. Also editorial comment and discussion of the disaster and the methods to effect a closure. 2800 w. Eng News—Feb. 21, 1907. No. 82535.

Closing Latest Break of the Colorado

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River into the Salton Sea. Gives a map showing the latest break of the Colorado River, and an illustrated description of the methods of overcoming the difficulty. This break was closed Feb. 11, at 6 P. M. 800 w. R R Gaz—Feb. 15, 1907. No. 82405.

The New Inland Sea. Arthur P. Davis. Describes the Colorado River and the irrigation projects for utilizing its waters, especially the disaster which turned the waters mainly into the Salton Sea, and the desperate attempts to regain control of the river. Ills. 4500 w. Nat Geog Mag—Jan., 1907. No. 82047 C.

Docks.

The New Naval Docks at Davenport. An illustrated detailed description of this extensive addition to the naval resources of Great Britain. 7800 w. Plates. Engng—Feb. 15, 1907. Serial. 1st part. No. 82606 A.

Drainage.

Drainage Canal at Hertogenbosch, Holland (Het afwateringskanaal van 's Hertogenbosch naar Drongelen). J. P. Wijtenhorst. Ills. 3600 w. De Ingenieur—Dec. 29, 1906. No. 82315 D.

Dredge.

A Powerful Dredge Equipped with a Cable Storage Drum. Illustrates and describes the dredge "Majestic," in use on the St. Mary's River improvement, Michigan. 1600 w. Eng News—Feb. 7, 1907. No. 82183.

Harbors.

The Harbors of South Africa; with Special Reference to the Causes and Treatment of Sand-Bars. Cathcart William Methven. Information concerning the harbors on the Southeast African coast. Considers principally the physical features affecting these harbors, and some of the problems that arise in dealing with bars on this sandy coast. Also discussion. Ills. 29500 w. Inst of Civ Engrs—No. 3602. No. 82042 N.

The Modern Development of British Fishery Harbors. H. C. M. Austen. Discusses the importance to the United Kingdom, of the fishery harbors and the causes of their modern extension; the effect of the change in the character of the fishing vessels, and the engineering aspects of the subject generally. Map. 3300 w. Engng—Feb. 8, 1907. Serial. 1st part. No. 82465 A.

The Midland Railway Company's Harbor at Heysham, Lancashire. George Neill Abernethy. A detailed description of the construction and equipment of this harbor, designed to provide increased accommodation for traffic to Ireland, and the Isle-of-Man. Plate. 4000 w. Inst of Civ Engrs—No. 3635. No. 82040 N.

Ohio River.

Government Improvement of the Ohio River from End to End. One of the Most Important Undertakings Now Before Congress. Remarks on the importance of this work and the cause of the delay, describing the location of the river and the many manufactures carried on along its banks. 2500 w. Naut Gaz—Feb. 14, 1907. No. 82425.

Panama.

Isthmian Canal. C. L. Chester. An outline of the points connected with the Panama Canal. General Discussion. 5500 w. Pro N Y R R Club—Jan. 18, 1907. No. 82269.

Progress on the Panama Canal. Fullerton L. Waldo. An illustrated account of things observed during a visit in Dec., 1906. 4000 w. Cassier's Mag—Feb., 1907. No. 82281 B.

The Panama Canal—The "Lock Canal" Type and the "Straits of Panama" Type Phillippe Bunau-Varilla. An illustrated article discussing the system of construction, the lock canal, past and present works and projects, with related matters. General discussion follows. 21500 w. Jour Soc of Arts—Jan. 25, 1907. No. 82289 A.

Sea Coast.

Repairing Damage Resulting from the Storm of March 12, 1906, on the Coast of Zeeland (Over eenige verchijnselen waargenomen in Zeeland bij den stormvloed van 12 Maart 1906). R. L. R. de Muralt. Ills. 3300 w. De Ingenieur—Dec. 22, 1906. No. 82302 D.

Teredo.

The Teredo in South Africa. Data concerning the methods used to meet the difficulty, due to ravages of the teredo, along the coast. Also discussion. 5000 w. R R Gaz—Feb. 1, 1907. No. 82082.

MISCELLANY.

Caisson Disease.

Compressed Air Illness or Caisson Disease. Abstract translation of a lecture by Thomas Oliver, giving a physiological and clinical study of the effects of work in compressed air. 3000 w. Compressed Air—Feb., 1907. No. 82494.

Salaries.

The Compensation of Engineers. J. D. Blackwell. Abstract of Presidential address before the Pacific Soc. of Eng. 1000 w. Eng News—Feb. 7, 1907. No. 82399.

Stresses.

Further Note on Summation of Stresses in Certain Structures. John C. Trautwine, Jr. Briefly reviews arguments in a paper by Mr. Carl Hering on this subject, and gives an elaboration leading to a more complete generalization. Discussion. 6500 w. Pro Engrs' Club of Phila—Jan., 1907. No. 82551 D.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

The First Atlantic Cable. John Mullaly. An account of the first Atlantic telegraph expeditions from the pen of an eye-witness, who was personally connected with the work. 2500 w. Jour Fr Inst—Feb., 1907. Serial. 1st part. No. 82063 D.

Microphone.

A New Compensating Microphone. Illustrates and describes the construction and states the advantages claimed. 1800 w. Elec Engr, Lond—Feb. 1, 1907. No. 82241 A.

Radio-Telegraphy.

Portable Wireless Outfits for U. S. Signal Corps. C. H. Cloudy. Illustrated detailed description of a field wireless set. 800 w. Elec Wld—Feb. 16, 1907. No. 82432.

Radio-Telegraph Installation for Signalling Across the Wash. Illustrates and describes an installation for signalling over a distance of 16 miles across the Wash, between Hunstanton and Skegners. 1200 w. Elec Rev, Lond—Feb. 8, 1907. No. 82455 A.

The Making and Using of a Wireless Telegraph Tuning Device. A. Frederick Collins. The fourth of a series of articles dealing with a 100-mile wireless telegraph set. Ills. 1600 w. Sci Am Sup—Feb. 16, 1907. No. 82424.

The Installation and Adjustment of a 100-Mile Wireless Telegraph Set. A. Frederick Collins. The third of a series of articles on related topics. Describes the installation, giving plan of arrangement of apparatus. Ills. 2200 w. Sci Am Sup—Feb. 9, 1907. No. 82178.

The Location and Erection of a 100-Mile Wireless Telegraph Station. A. Frederick Collins. Gives data relating to the location and erection of a station, using the instruments described in an earlier article. Ills. 2500 w. Sci Am Sup—Feb. 2, 1907. No. 82088.

The Theory and Action of a 100-Mile Wireless Telegraph Set. A. Frederick Collins. The fifth of a series of related articles explaining the theory and working of the instruments employed. Diagrams. 2500 w. Sci Am Sup—Feb. 23, 1907. No. 82583.

Trans-Atlantic Wireless Telegraphy. Illustrates and describes the construction of the tower at Machrihanish, N. B., for Trans-Atlantic service. This tower was blown down by a storm and the cause of the disaster is explained and details described. 1600 w. Engng—Jan. 25, 1907. No. 82153 A.

Radio Telephony.

Wireless Telephony. R. A. Fessenden. Briefly discusses the present status, and future prospects, and begins a review of the developments. Ills. 2000 w. Elec Rev, Lond—Feb. 15, 1907. Serial. 1st part. No. 82600 A.

The Continuous Production of High-Frequency Oscillations. R. A. Fessenden. Gives a short historical résumé dealing principally with arc methods used by the writer for producing high-frequency oscillations, and their application to wireless telephony. 2800 w. Elect'n, Lond—Feb. 15, 1907. Serial. 1st part. No. 82603 A.

Relays.

Telephonic Relays (Le Relais Téléphonique). —— Henry. Review of the different types now in use. Ills. 3800 w. L'Electricien—Jan. 19, 1907. No. 82347 D.

Telegraphy.

Pollak and Virag Rapid Telegraph System (Télégraphe Rapide Système Pollak et Virag). M. D. Korda. Comprehensive description of this device and the results achieved with it. Ills. 4200 w. Bulletin De La Société Internationale Des Electriciens—No. 60. Dec., 1906. No. 82317 F.

Telephony.

Poulsen's Telephonic Message Recorder. Illustrates and describes this invention by means of which telephonic messages may be recorded or stored. 1000 w. Sci Am Sup—Feb. 23, 1907. No. 82582.

Central Battery Installations for Telephone Stations (Betrachtungen über Zentralbatterie-Schaltungen für Fernsprech-Amter). E. Neuhold. Arrangement of circuits described. Diagrams. 1700 w. Elektrotech Zeitschr—Jan. 24, 1907. No. 82353 B.

Some Phases of Telephone Manufacture. G. S. Macomber. Outlines the history of the rapid growth of the telephone industry, and the organization of the manufacturing company to obtain the highest efficiency, reviewing the operations required to produce the apparatus. Ills. 5000 w. Sib Jour of Engng—Feb., 1907. No. 82500 C.

Widening Applications of the Telephone. William Maver, Jr. An illustrated article calling attention to recent extension in the use of the telephone. 2000 w. Cassier's Mag—Feb., 1907. No. 82280 B.

The Application of the Telephone to Railway Service. C. J. H. Woodbury.

We supply copies of these articles. See page 158.

Abstract of a paper read before the New England St. Ry. Club. Brief account of some of the uses made of the telephone for railway service and the composite systems, making possible the use of the same wires for the telegraph and telephone. 2200 w. Elec Rev, N Y—Feb. 23, 1907. No. 82557.

Telephotography.

Korn's Photographic Fac-Simile Telegraph. Information concerning one of the latest systems of reproducing photographic images at a distance by means of electricity. Ills. 1200 w. Sci Am—Feb. 16, 1907. No. 82421.

DISTRIBUTION.

Converters.

The Peebles-Bragstad-LaCour Converters. Illustrated detailed description. 1200 w. Elec Engr, Lond—Jan. 25, 1907. No. 82139 A.

Switchboard.

New Switchboard in the Hanoverian Technical High School (Die neue Haupt-Schaltanlage im Elektrotechnischen institute der Technichen Hochschule Hannover). E. Beckmann. Ills., diagrams. 1700 w. Elektrotech Zeitschr—Jan. 10, 1907. No. 82330 B.

Transformation.

The Transformation of Electrical Energy. C. Francis Harding. Considers in detail the direct and alternating current transformations which are necessary that the electrical energy may be distributed over a broad area in small units for varying uses. 3000 w. Sib Jour of Engng—Feb., 1907. No. 82469 C.

Three-Phase Transformation. A. S. McAllister. Discusses the relative merits of the three-phase transformer and the combination of single-phase transformers that may be employed for the same service. Also editorial. 2500 w. Elec Wld—Feb. 9, 1907. No. 82199.

Practical Notes on Transformer Testing. Ernest A. Reid. Read before the Dick-Kerr Engng. Soc. Describes the tests made by the makers before they leave the shop. 2500 w. Elec Engr, Lond—Feb. 1, 1907. No. 82242 A.

Upper Savoy.

Distribution of Electric Energy in Upper Savoy (Les Distributions D'Energie Electrique dans la Haute-Savoie). J. A. Montpellier. Description of generating and distributing plants. Map. 3600 w. L'Electricien—Jan. 26, 1907. No. 82348 D.

Distribution of Electric Energy in Savoy (Les Distributions D'Energie Electrique dans La Savoie). J. A. Montpellier. Description of the generating and distributing plants throughout the province of Savoy. Ills. 5300 w. Serial. 2 parts. L'Electricien—Jan. 5 and 12, 1907. No. 82345 D.

Wiring.

Wiring a Frame Dwelling with Flexible Metallic Conduit. Thomas W. Poppe. Suggestions, with illustrations, for an installation of flexible tubing. 1500 w. Elec Wld—Feb. 2, 1907. No. 82132.

ELECTRO-CHEMISTRY.

Caustic Soda.

McDonald Electrolytic Bleach and Caustic Soda Plant. J. R. Crocker. Illustrates and describes a plant installed at Johnsonburg, Pa., which has been in operation over a year. 700 w. Elec-Chem & Met Ind—Feb., 1907. No. 82201 C.

Electroplating.

Producing Rose-Gold Deposits. Explains the essential features for obtaining a good rose-gold deposit. 1000 w. Brass Wld—Feb., 1907. No. 82553.

Some Points on the Plating Barrel. An illustrated article giving suggestions in regard to running the plating machine. 1000 w. Brass Wld—Feb., 1907. No. 82554.

Insulating Films.

An Optical Study of the Thin Film Deposited by Electrolysis on an Aluminium Anode. O. M. Carbino. Abstract translation from *Il Nuovo Cimento*. Describes measurements by optical methods of the thickness of these films. 800 w. Elect'n, Lond—Jan. 25, 1907. No. 82146 A.

Nitrates.

The Artificial Production of Nitrates from the Atmosphere. J. B. Van Brussel. An illustrated description of the Birkeland and Eyde process for the production of nitric oxide. 1500 w. Eng News—Feb. 7, 1907. No. 82185.

Fixation of Nitrogen of the Air (Uber Fixierung des Stickstoffs der Luft und Verwendung der gewonnenen Körper). G. Erlwein. Ills. Serial. 2 parts. 4800 w. Elektrotech Zeitschr—Jan. 10 and 17, 1907. No. 82340 B.

Review, 1906.

The Electro-Chemical and Electro-Metallurgical Industries in 1906. John B. C. Kershaw. Gives details of the position of the various industries, the most progress having been made in the copper, iron, steel, and nitrogen industries. 3000 w. Elect'n, Lond—Feb. 8, 1907. No. 82458 A.

ELECTRO-PHYSICS.

Induction Coils.

The Construction of Induction Coils. William O. Eddy. Treats of some of the theoretical considerations and the technical designs of induction coils, dealing with methods of practical construction and the more important manufacturing details. 2000 w. Elec Wld—Feb. 2, 1907. No. 82131.

We supply copies of these articles. See page 158.

Polyphase.

The Calculation of Polyphase and Single-Phase Windings by Vector Diagram (Die Berechnung der Emk von Mehrphasen und Einphasen Wicklungen auf Grund eines Vektor diagrammes der Feldstärke). H. Görges. Extended mathematical treatment. Diagrams. 2900 w. Elektrotech Zeitschr—Jan. 3, 1907. No. 82328 B.

Rheostats.

Notes on Rheostat Design. F. D. Hallock. Considers points of interest in the design of rheostats employed in series circuits, and in shunt circuits. 2000 w. Elec Jour—Feb., 1907. No. 82492.

Sparking.

Calculation of Dynamo Sparking Characteristics. Carlton L. Kennedy. Discusses the determining of the limiting commutating current from the standpoint of reactance voltage, also considering the effect of armature current, and the influence of a displacement of the brushes. 2400 w. Elec Wld—Feb. 16, 1907. No. 82431.

Transformer.

Resonance Transformer (Der Resonanz Transformator). Gustav Benischke. Mathematical paper. Diagrams. 1300 w. Elektrotech Zeitschr—Jan. 10, 1907. No. 82329 B.

Wave Distortion.

Effect of Iron in Distorting Alternating-Current Wave-Form. C. P. Steinmetz. Deals with a paper by Messrs. Bedell & Tuttle, read before the Am. Inst. of Elec. Engrs., in which the writers discussed the relation between the harmonics introduced by iron into the alternating-current wave and the hysteresis loop of the iron to which these harmonics were due. 3800 w. Elect'n, Lond—Jan. 25, 1907. No. 82148 A.

GENERATING STATIONS.

Alternators.

Self-Regulating Alternator with Auxiliary Field. A. Heyland. Illustrated description of an innovation aiming to counteract the demagnetizing action of the armature magnetomotive force of the load current on the magnetic field of the machine, and on the fall of potential. 2000 w. Elec Wld—Feb. 23, 1907. No. 82542.

Alternators with Auxiliary Regulating Field. A. Heyland. Gives a summary of a previous article on this subject, in which the theory of this new method of compensating and compounding alternators was developed, and shows how to determine the necessary alterations for any given alternator. Ills. 4000 w. Elect'n, Lond—Feb. 8, 1907. Serial. 1st part. No. 82457 A.

Instructions for Installing and Operating Alternating-Current Generators. Instructions taken from a book prepared by the Allis-Chalmers Company for the use of its customers. Ills. 2500 w. Elec Rev, N Y—Feb. 2, 1907. No. 82104.

Breakdowns.

On the Prevention of Breakdowns in Central Stations. An explanation of methods used by the writer for keeping the number of interferences with the supply of electricity down to the minimum. 2500 w. Elec Rev, Lond—Feb. 8, 1907. No. 82454 A.

Condensers.

High-Voltage Condensers. C. L. Durand. Explains the advantages of the use of condensers, their applications and features. Ills. 1500 w. Elec Rev, N Y—Feb. 16, 1907. No. 82407.

Hydro-Electric.

Recent Hydraulic Power Developments in Switzerland. Enrico Bignami. Illustrates and describes recent hydro-electric installations designed to utilize the power of the River Orbe, which forms the outlet of the lakes of Joux. 2000 w. Cassier's Mag—Feb., 1907. No. 82284 B.

Electric Power Canal at Lake Constance (Les Usines Electriques Du Canal De Derivation du Rhin en amont du lac de Constance). S. Herzog. Description of water power plants deriving energy from the Rhine between Austria and Switzerland. Ills. 1400 w. Le Génie Civil—Jan. 5, 1907. No. 82325 D.

The Ticino River Hydro-Electric Plants in Italy. Frank C. Perkins. Illustrated descriptions of an interesting modern installation using the latest methods. 1700 w. Elec Engr, Lond—Jan. 25, 1907. No. 82138 A.

The Hydro-Electric Plant of the Utica Gas and Electric Company. Illustrated description of this plant in central New York, and its wooden stave pipe line. 900 w. Elec Rev, N Y—Feb. 23, 1907. No. 82556.

The St. Louis River Hydro-Electric Plant. Describes a plant under construction in Minnesota to furnish power for working the iron mines in the Missabe range, at 70 miles distance, and to furnish current for light and power to Duluth and also to St. Paul and Minneapolis, 125 miles distant. 2000 w. Engr, Lond—Feb. 15, 1907. No. 82611 A.

Municipal Plant.

South Norwalk Municipal Electric Works. Illustrated description of a successful plant in Connecticut which furnishes power for street and commercial lighting. 2000 w. Munic Jour & Engr—Feb. 6, 1907. No. 82171 C.

Trezzo D'Adda.

The Trezzo D'Adda Electric Power

We supply copies of these articles. See page 158.

Station. Illustrated description of this Italian station and its equipment. 1600 w. Engng—Feb. 8, 1907. No. 82466 A.

LIGHTING.

Arc Lamps.

The Magnetite Arc Lamp. J. S. R. Hyden. Illustrates and describes this improvement on the carbon lamp, explaining the mechanism. 1200 w. Cassier's Mag—Feb., 1907. No. 82283 B.

Long Flame and Chemical Arcs. W. R. Ridings. Read before the British Westinghouse Engrs. Club. Considers the history and development of the flame arc lamp, and the efficiency and advantages of the flame arc lamp over the pure carbon type. 2000 w. Elec Engr, Lond—Feb. 8. 1907. No. 82453 A.

Illumination.

Lighting of the State Capitol at Harrisburg, Pa. An illustrated article describing this beautiful State building, and the arrangements for artificial lighting by electricity. 3500 w. Elec Wld—Feb. 2, 1907. No. 82129.

Incandescent Lamps.

Investigations on Light Standards and the Present Condition of the High-Voltage Glow Lamp. Clifford C. Paterson. An illustrated account of tests, made at the National Physical Laboratory, giving facts of value to the electrical and gas industries. Deals with flame standards and other tests. 12600 w. Inst of Elec Engrs—Jan. 24, 1907. No. 82057 N.

Investigations on Light Standards and the Present Condition of the High- Voltage Glow Lamp. Clifford C. Patterson. Abstract of a paper read before the Inst. of Elec. Engrs. An account of investigations carried out at the National Physical Laboratory. The first part deals with the standards of light; the second part with commercial glow-lamp testing. 5500 w. Elect'n, Lond—Jan. 25, 1907. Serial. 1st part. No. 82145 A.

The Standard Specification for Carbon Glow Lamps: A Criticism. Lancelot W. Wild. A criticism of tests proposed, with suggestions. 1600 w. Elec Rev, Lond—Feb. 15, 1907. No. 82602 A.

Ratio of the Carcel, Hefner and Vernon-Harcourt Standards of Light (Etude Sur Le Rapport Des Trois Lampes Carcel, Hefner et Vernon-Harcourt). Laporte and Jouaust. Relative luminosity of these standards discussed on the basis of results obtained by various investigators. 3300 w. Bulletin De La Société Internationale Des Electriciens—No. 58, Oct., 1906. No. 82316 F.

Comparative Life Tests on Carbon, Nernst, and Tantalum Incandescent Lamps Using Alternating Currents. H. F. Haworth, T. H. Matthewman, and D. H. Ogley. Tests made to determine whether the working of such lamps was in any degree different with alternating-current than when using continuous current. Ills. 4500 w. Inst of Elec Engrs—Feb. 7, 1907. No. 82615 N.

Modern Types of Electric Lamps (Modern Elektrische Lichtbronnen). E. J. F. Thierens. Comparison of principal lamps now in use. 5400 w. De Ingenieur—Jan. 12, 1907. No. 82337 D.

Mirrors.

Parabolic Mirrors for Incandescent Lamps (Parabolspiegel mit elektrischem Glühlicht). Georg König. Discussion of advantages gained by use of mirrors for incandescents and for Nernst lamps. Diagrams. 4200 w. Elektrotech Zeitschr—Jan. 17, 1907. No. 82331 B.

MEASUREMENT.

Cables.

On the Effective Capacities of Cables and Their Determination by the Ballistic Method. W. Akemann. Abstract translation from *Elektrotechnische Zeitschrift.* Defines the effective capacity of any conductor of a multi-core cable, and shows how to determine it by the ballistic method, the investigation being extended to cables with pilot wires. 800 w. Elect'n, Lond—Feb. 8, 1907. No. 82460 A.

The Effective Capacity of Large Current Cables, and Their Measurement with Direct Current (Uber die wirksame Kapazität von Starkstromkabëln und ihre einheitliche Messung mit Gleichstrom). W. Akemann. Mathematical treatment. Diagrams. 1800 w. Elektrotech Zeitschr—Jan. 3, 1907. No. 82327 B.

Galvanometer.

A New Type of Alternating-Current Galvanometer of High Sensibility. W. S. Franklin and L. A. Freudenberger. From the *Physical Review.* Illustrates and describes a Kelvin astatic galvanometer modified so as to be suitable for alternating currents. 1200 w. Elect'n, Lond—Feb. 8, 1907. No. 82461 A.

Hysteresis.

Measurement of the Hysteretic Loss at Slow Cycles. Dr. Gisbert Kapp. Describes a method that can be carried out by one observer, for which no special apparatus is needed. 600 w. Elec Engr, Lond—Feb. 15, 1907. No. 82598 A.

Meters.

A New Form of Induction Ammeter or Voltmeter. Paul MacGahan. Describes the induction principle as applied to the modern Westinghouse alternating-current type of meters. Ills. 9000 w. Elec Jour—Feb., 1907. No. 82493.

Polyphase Metering Conventions. M. C. Rypinski. Outlines briefly some features of the Westinghouse apparatus. Ills. 600 w. Elec Jour—Feb., 1907. No. 82491.

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Warrantable Expense for Meter Testing. Oliver J. Bushnell. Read before the N.-W. Elec. Assn. Gives a brief study of conditions affecting meter accuracy, discussing methods used, and related facts, with cost. 4200 w. Elec Rev, N Y —Feb. 9, 1907. No. 82220.

Photometers.

The Theory of Flicker Photometers. J. S. Dow. Considers some of the chief points arising in the design and use of such instruments. 2200 w. Elect'n, Lond —Feb. 1, 1907. Serial. 1st part. No. 82248 A.

Reactance Voltage.

Graphical Diagram for Determining the Reactance in Alternating Current Circuits. T. W. Varley. Gives a diagram, equivalent to a straight line plotted from rectangular logarithmic co-ordinates, illustrating its use by an example. 600 w. Elec Wld. Feb. 9, 1907. No. 82198.

Resistivity.

Resistivity-Temperature Formulæ for Copper. Dr. F. B. Crocker. Shows that there is considerable difference of usage among electrical engineers. 1500 w. Elec Wld—Feb. 23, 1907. No. 82541.

Three Phase.

Measurement of Power in Three-Phase Systems (Notiz über die Leistungsmessung in Drehstrom-Systemen mit Nulleiter). E. Orlich. Mathematical discussion. 500 w. Elektrotech Zeitschr—Jan. 24, 1907. No. 82341 B.

Measurement of Power in Three-Phase Circuits (Leistungsmessungen bei Drehstrom). F. E. Mathematical paper. Diagrams. 1600 w. Elektrotechnik und Maschinenbau—Jan 6, 1907. No. 82300 D.

MOTORS.

Single-Phase.

Single-Phase Motors. H. R. Speyer. Considers briefly the induction motor and the series repulsion motor, and motors combining the two types and their characteristics. Ills. 2500 w. Elec Engr, Lond—Feb. 1, 1907. Serial. 1st part. No. 82240 A.

Starter.

New Motor Starter. Brief illustrated description of the "helical drum starter" which is essentially different from anv in present use. 1000 w. Elec Rev, Lond —Feb. 15, 1907. No. 82601 A.

Windings.

Series vs. Parallel Windings in Alternating-Current Motors. R. E. Hellmund. Gives a comparison between parallel and series connections. 1200 w. Elec Wld—Feb. 23, 1907. No. 82543.

TRANSMISSION.

Wire.

Hard-Drawn Copper Wire. Thomas Bolton. Gives an account of results obtained in a number of tests recently carried out, to acquire data which might assist toward the framing of standard specifications for all sizes of wire. 1800 w. Elec Rev, Lond—Jan. 25, 1907. No. 82141 A.

Specifications for Line Wire. F. F. Fowle. Views based on experience of a telephone engineer. General discussion also. 6800 w. Pro Ry Sig Assn—1906. No. 82479 N.

MISCELLANY.

Coal-Tipping.

A Novel German Electric Coal-Tipping Device. Frank C. Perkins. Illustrations, with brief description. 400 w. Sci Am Sup—Feb. 2, 1907. No. 82087.

Electric Applications.

Applications of Electricity in the Mess Hall at West Point, N. Y. Illustrates and describes many and varied uses of electricity. 1500 w. Elec Wld—Feb. 23, 1907. No. 82540.

The Field of Electric Alternating-Current Service. H. S. Knowlton. Discusses the special field of usefulness of alternating-current service, with particular reference to the use of the single-phase electric motor. 1800 w. Cassier's Mag—Feb., 1907. No. 82287 B.

The American Co-operative Electrical Development Association. R. Borlase Matthews. An explanation of the object and work of this association for the promotion of the use of electricity for light, heat and power. 3000 w. Elec Rev, Lond—Feb. 8, 1907. No. 82456 A.

Electric Heating.

Electric Heating and Its Application to the Fusion and Firing of Refractory Materials. R. S. Hutton. Gives an account of some advances being made in the application of electric heating, such as laboratory and experimental uses and industrial processes. 3000 w. Elec Rev, N Y—Feb. 23, 1907. No. 82558.

Electric Heating and Its Application to the Fusion and Firing of Refractory Materials. R. S. Hutton. Abstract of a paper read before the English Ceramic Soc. Divides the paper into laboratory applications and industrial processes. Describes different types of furnaces for laboratory use, and gives details of the manufacture of carborundum, and other refractory materials. 2000 w. Elect'n, Lond —Jan. 25, 1907. No. 82149 A.

Exposition.

Electric Power Exhibits at Milan Exposition (Die Elektrotechnik auf der internationalen Ausstellung in Mailand). Alfred Grünhut. Description of motors and controllers for traction and stationary purposes. Ills. Serial. 2 parts. 7700 w. Elektrotech und Maschinenbau—Jan. 20 and 27, 1907. No. 82335 D.

We supply copies of these articles. See page 158.

London.

Electric Power Supply in London. R. L. Pearson. Information relating to this subject, describing in detail some of the extensions of plant recently made and giving a résumé of the earlier features of the undertakings, showing progress of electrical energy supply for power purposes. Ills. 2000 w. Elect'n, Lond—Feb. 1, 1907. Serial. 1st part. No. 82247 A.

Progress.

The Progress of Electrical Science in 1906. E. E. Fournier d' Albe. An interesting review. 2800 w. Elect'n, Lond—Jan. 25, 1907. No. 82147 A.

INDUSTRIAL ECONOMY

Apprenticeship.

Apprenticeship. James Parsons. An account of the objects and work of an Apprenticeship and Skilled Employment Committee, with comments. 11000 w. Jour Soc of Arts—Feb. 1, 1907. No. 82230 A.

Channel Tunnel.

The Channel Tunnel. Walter H. James. Discusses both the military and commercial sides of the question, presenting arguments unfavorable to the construction. 4500 w. Contemporary Rev—Feb., 1907. No. 82488 D.

The Revived Channel Tunnel Project. Gives 6 short articles by prominent men of England protesting against the connection of England and France by a tunnel under the Channel. Also a reprint of a protest published in 1883. 65000 w. Nineteenth Cent—Feb., 1907. No. 82487 D.

Cost Systems.

Labor: Individual Shop Orders and Groups of Orders. F. E. Webner. Sixth of a series of articles on cost keeping. Discusses the utilization of scrap or waste stock, and matters relating to shop orders. 1200 w. Ir Trd Rev—Feb. 7, 1907. No. 82182.

Cost Reduction Through Cost Comparison. C. E. Knoeppel. The present paper refers only to burden costs. Explains a system devised by the writer, illustrating by an example. 2500 w. Engineering Magazine—March, 1907. No. 82639 B.

Education.

Technical Education of Apprentices in Connection with Actual Practice. S. M. Dolan. Deals particularly with the supplementary education of railroad apprentices, showing what has been done at the Missouri Pacific Ry. shops at Sedalia, Mo. Ills. 2700 w. Pro St Louis Ry Club—Jan. 11, 1907. No. 82266.

The Weak Point in Our Systems of Industrial Education. H. F. J. Porter. Discussion of the A. S. M. E. paper, "A Plan to Provide for a Supply of Skilled Workmen," by M. A. Alexander. 2200 w. Am Mach. Vol 30. No. 6. No. 82170.

Engineering School.

The United States Naval Academy as an Engineering School. Walter F. Worthington, Commander, U. S. N. An illustrated article giving information in regard to the training for naval officers at Annapolis in engineering, and the writer's conclusions concerning its value. 2500 w. Engineering Magazine—March, 1907. No. 82633 B.

Iron Industry.

The Mechanical Development of the German Iron Industry. J. H. Cuntz. An illustrated review discussing the importance of by-product coking, the utilization of furnace gases, and advanced practice in electric driving, as factors affecting the economy in the German iron industry. 3300 w. Engineering Magazine—March, 1907. No. 82637 B.

Labor.

A Plan to Provide a Supply of Skilled Workmen. Discussion of paper by M. W. Alexander. 4000 w. Pro Am Soc of Mech Engrs—Feb., 1907. No. 82502 F.

Insurance of Labor in Italy. Editorial on the Italian law which deals with the compensation to workmen for accidents, and some of the frauds perpetrated, with an explanation of the National Provident Fund. 2300 w. Engng—Feb. 1, 1907. No. 82296 A.

Management.

Profit Making in Shop and Factory Management. C. U. Carpenter. This third article of a series on the application of the "Committee System of Management," deals with the drafting-room and the tool-room, and the requirements for efficient work. 4500 w. Engineering Magazine—March, 1907. No. 82640 B.

Patents.

The Cost of a Golden Age. A. S. Fitch. Remarks on the achievements of the past half century in the line of important inventions, showing the debit side of the patent account. 2800 w. Am Mach—Vol. 30, No. 6. No. 82166.

Safety Devices.

First International Exposition of Safety Devices and Industrial Hygiene. An account of the exhibition at the American Museum of Natural History, New York City, of safety devices for the prevention of accidents to workmen. Also editorial.

We supply copies of these articles. See page 158.

4500 w. Eng News—Feb. 14, 1907. No. 82295.

Testing.

The National Physical Laboratory as a Commercial Testing Establishment. Reprint articles bearing upon the policy of the National Physical Laboratory of England, with criticism. 5400 w. Engr, Lond—Feb. 15, 1907. No. 82610 A.

Trade Secrets.

The Ethics of Trade Secrets. Frederick P. Fish. Remarks on the part trade secrets have played in the industries of the past, and the present laws for the protection of such information, giving test cases, and showing their justice. 12800 w. Pro Am Soc of Mech Engrs—Feb., 1907. No. 82501 F.

Tyneside.

Tyneside Industrial Progress and Prospects. A review of the industrial situation and economic conditions of this district and its suitability for new works; its industrial progress and prospects. Map. 5000 w. Engng—Feb. 1, 1907. Serial. 1st part. No. 82252 A.

MARINE AND NAVAL ENGINEERING

Battleships.

The Battleship of the Future. Forrest E. Cardullo. A discussion of the "Dreadnought," and the general lines along which battleship design may be expected to progress. Ills. 3000 w. Sci Am—Feb. 9, 1907. Serial. 1st part. No. 82177.

Notes on the Development of Warship Design. R. H. M. Robinson. Read before the Soc. of Nav. Archts. & Marine Engrs. Discusses points in the development, construction and equipment of warships. 9000 w. Marine Rev—Jan 31, 1907. No. 82099.

Coaling.

The "Express" Coal-Bagging Lighter for Coaling War Vessels in Harbor. Illustrates and describes a new type of coal-bagging lighter being tried by the British naval authorities. 2000 w. Sci Am—Feb. 2, 1907. No. 82083.

Cruiser.

The Peruvian Cruiser Coronel Bolognesi. Illustrated description. 800 w. Engr, Lond—Feb. 1, 1907. No. 82261 A.

The Steam Trials of the Armored Cruiser "Warrior." Illustrates the four-cylinder triple-expansion engines, reporting the successful trials, and giving general information. 800 w. Engng—Feb. 8 1907. No. 82468 A.

Destroyers.

New Italian Torpedo-Boat Destroyers. Illustrates and describes recent boats of this class. 700 w. Naut Gaz—Feb. 14, 1907. No. 82426.

Diving Apparatus.

The De Pluvy Diving Apparatus. Illustrates and describes a suit of metallic armor which will resist great pressure and thus enable a diver to descend 300 ft. or more. 1200 w. Sci Am Sup—Feb. 2, 1907. No. 82090.

Ferries.

Ferry-Steamers for the Hooghly. Illustrations and description of the engines fitted into one of seven twin-screw ferry steamers for the Port of Calcutta. Brief description of the vessels also. 700 w. Engng—Feb. 1, 1907. No. 82254 A.

The Car Ferry Traffic of Lake Erie. W. Frank M'Clure. Illustrates and describes the service between Onio and Canadian harbors, especially the transport of coal in winter. Shows various types of vessels. 1300 w. Sci Am—Feb. 16, 1907. No. 82422.

Hydroplane Boats.

Recent Performances of French Hydroplane Boats. An illustrated account of the remarkable performance of hydroplane gliding boats in the vicinity of Paris, describing details of interest. 2500 w. Sci Am. Feb. 23, 1907. No. 82572.

Milan Congress.

The Milan Navigation Congress of 1905; and Italian Navigation Works and Ports Visited. Leveson Francis Vernon-Harcourt. An account on the visits to works at the conclusion of the proceedings at Milan. 13500 w. 2 plates. Inst of Civ Engrs—No. 3621. No. 82034 N.

Models.

The Model-Maker of Maiden Lane. Illustrates some fine marine models and other work executed at a shop in New York City. 1600 w. Am Mach—Vol. 30. No. 6. No. 82167.

Motor Boats.

Marine Oil Engine for Commercial Purposes. A. F. Evans. Abstract of a paper read before the British Motor Boat Club, upon the underlying principles of the motor boat in commerce. 1700 w. Auto Jour—Feb. 9, 1907. No. 82450 A.

Influence of the Automobile on Launch Development. W. P. Stephens. Notes on recent development, describing some of the types and the improvements in engine design. 1500 w. Sci Am—Feb. 23, 1907. No. 82574.

The Motor Torpedo Boat—A New Type—Illustrated description of the Yarrow motor torpedo boat for the British Navy. 500 w. Sci Am Sup—Feb. 23, 1907. No. 82579.

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Latest Types of Cruising Power Boats. Illustrated description of recent types, with editorial on the trend of motor-boat development. 2700 w. Sci Am—Feb. 23, 1907. No. 82573.

Naval Efficiency.

Personnel—A Vital Factor in Naval Efficiency. Walter M. McFarland. An introduction to a paper, by Commander Worthington, on naval education and the training given at the U. S. Naval Academy at Annapolis. 1000 w. Engineering Magazine—March, 1907. No. 82632 B.

Ore Shipment.

The Transportation and Shipment of Ore. Introductory remarks on methods of handling iron and copper ores in Spain, with an illustrated detailed description of the storage and shipment arrangements at Almeria, Spain. 3000 w. Engng—Jan. 25, 1907. Serial. 1st part. No. 82152 A.

Propellers.

Experiments with Ship Propellers (Vergleichsversuche an Schiffschrauben). H. Lorenz. Mathematical treatment. Diagrams and tables. 2200 w. Zeitschr d Vereines Deutcher Ingenieure—Jan. 5, 1907. No. 82355 D.

Propulsion.

Marine Gas Propulsion in Relation to Imperial Commerce and Defence. A. Vennell Coster. Discusses the relative merits of gas reciprocating engines, steam turbines, and steam reciprocating engines for marine purposes, and explains a safe scheme of marine gas propulsion. Ills. 4500 w. Engr, Lond—Feb. 15, 1907. No. 82613 A.

The Damage to the Steamer Martha Woermann (Die Havarie des Hamburger Dampfers "Martha Woermann"). Hugo Buchholz. Description of rapid work in repairing a broken rudder and stern post. Illus. 2400 w. Zeitschr d Vereines Deutscher Ingenieure—Jan. 19, 1907. No. 82360 D.

Sailing Vessels.

The Passing of American Square-Rigged Vessels. James G. McCurdy. Remarks on the rapid disappearance of this type of vessel, and the conditions causing it. Ill. 1500 w. Sci Am Sup—Feb. 16, 1907. No. 82423.

Sea-Rafts.

The Sea-Rafts of the North-West. Day Allen Willey. An illustrated article showing the enormous dimensions and general construction of these timber rafts. 1200 w. Sci Am—Feb. 2, 1907. No. 82085.

Shipbuilding.

The World's Shipbuilding in 1906. Gives tables showing the tonnage of vessels launched during the years 1892-1906, with remarks on the output of the last year, and related matters. 2000 w. Engng—Feb. 1, 1907. No. 82255 A.

Signalling.

Submarine Signalling by Means of Sound. An illustrated review of the development of submarine signalling, describing the application at Liverpool. The method consists essentially of a bell as a transmitter, and a tank containing a solution and a microphone as a receiver. 2000 w. Elect'n, Lond—Jan. 25, 1907. No. 82143 A.

Submarines.

The Stability of Submarines. J. G. Johnstone. Describes the important features in a submarine of the diving type, and considers the statical stability and the stability of motion. 3 Plates. 6500 w. Trans Inst of Engrs & Shipbldrs in Scotland—Jan. 22, 1907. No. 82631 N.

Turbine Steamers.

Cunard Steamers Mauretania and Lusitania (Les Paquebots Géants de la Compagnie Cunard). L. Piaud. Description of these great turbine steamers. Illus. 2800 w. Le Génie Civil—Dec. 29, 1906. No. 82320 D.

Wharf.

The United States Coaling Wharf, Guantanamo, Cuba. Illustrates and describes a wharf for the storage of 20,000 tons of coal and a coal handling plant with a capacity of 200 tons per hour, now under construction. 1000 w. Eng Rec—Feb. 9, 1907. No. 82227.

MECHANICAL ENGINEERING

AUTOMOBILES.

Bodies.

The Names of Motor Carriage Bodies. Explanation of leading types in use, with drawings and index. 2000 w. Autocar—Jan. 26, 1907. No. 82135 A.

Our Vile Bodies. G. Stuart Ogilvie. A discussion of the form of body most suitable for a general utility car. 1800 w. Autocar—Feb. 2, 1907. Serial. 1st part. No. 82235 A.

Change-Speed.

The Stanley Automatic Change-Speed Gear. Illustrated description of a mechanism which, by automatically changing the gears as required, renders a side lever unnecessary. 2500 w. Auto Jour—Feb. 9, 1907. No. 82448 A.

The Wicksteed Change-Speed Gear. Drawing and description of the construction, showing the manner in which the individual clutches are arranged and oper-

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ated. 1000 w. Auto Jour—Feb. 9, 1907. No. 82449 A.

Cylinders.

The Number of Cylinders. Report of a discussion at the Automobile Club in England on "Six-Cylinder Engines v. Four-Cylinder Engines." 9000 w. Autocar—Feb. 16, 1907. No. 82587 A.

Driving.

Four Wheel Driving and Steering for Electric Automobiles (Elektromobil mit Vierräderantrieb und Vierräderlenkung). E. H. Geist. Description of a car driven by gas-engine dynamo-motor combination with all four wheels drivers. Illus. 1600 w. Zeitschr d Mit Motorwagen Ver—No. 23, Dec., 1906. No. 82309 D.

Fawcett-Fowler.

The Fawcett-Fowler Steam Car. Illustrates and describes a new steam-propelled car, shown at the Liverpool Exhibition. 1000 w. Auto Jour—Feb. 2, 1907. No. 82232 A.

Fuels.

Comparative Test of Alcohol, Kerosene, and Gasoline as Automobile Fuels. Report of a run from New York to Boston, of three identical cars, using the fuels named, giving interesting facts brought out. 1200 w. Sci Am—Feb. 9, 1907. No. 82175.

Grout.

The Grout for 1907. Illustrates and describes this car. The only changes in the new model are in the way of conveniences and appointments. 900 w. Automobile—Feb. 7, 1907. No. 82173.

Hispano Suiza.

A Promising Car from Spain. Illustrated description of the Hispaño Suiza car, shown at Birmingham. 1100 w. Autocar—Jan. 26, 1907. No. 82136 A.

Ignition.

Essential Elements of Electric Ignition. Charles B. Hayward. An explanation of the rudiments, to be followed by a consideration of the various systems of ignition and a statement of their advantages and disadvantages, etc. 3000 w. Automobile—Feb. 21, 1907. Serial. 1st part. No. 82536.

"Kisselkar."

The Kissel Kar. Illustrated description of a popular-priced car built in Wisconsin. 1200 w. Automobile—Jan. 31, 1907. No. 82067.

London Show.

The London Automobile Exhibition (Die Londoner Automobil-Ausstellung). Herbert Bauer. Description of cars at this show, with particulars of engines and general details. Illus. 4600 w. Zeitschr d Mit Motorwagen Ver—No. 23, Dec., 1906. No. 82305 D.

Magnetos.

Simms-Bosch High-Tension Magnetos. Illustrated description of various types. 2000 w. Autocar—Feb. 9, 1907. No. 82452 A.

Motor Cycles.

Motor Cycles at the International Auto Show, Berlin (Die Motorräder auf der Intern. Automobil-Ausstellung, Berlin). Wolfgang Vogel. Detailed description of different types shown at Berlin. Illus. 2800 w. Zeitschr d Mit Motorwagen Ver—No. 24, Dec., 1906. No. 82307 D.

Omnibuses.

Motor Omnibuses. Lord Montagu of Beaulieu. Information in regard to motor omnibuses running in London, discussing their advantages and disadvantages. General discussion. 7500 w. Jour Soc of Arts—Feb. 15, 1907. No. 82584 A.

Motor Cars for Public Service in Paris and Berlin (Automobile im öffentlichen Verkehr von Paris und Berlin). Herbert Bauer. Description, tables of fares, speeds attained, etc. Illus. 5100 w. Zeitschr d Mit Motorwagen Ver—No. 22, Nov., 1906. No. 82304 D.

A New Krieger Gasoline-Electric Omnibus for Use in Paris. Illustrated description. 800 w. Sci Am Sup—Feb. 2, 1907. No. 82089.

Petrol-Electric.

Petrol-Electric Transmission for Road Vehicles in Comparison with Purely Mechanical Systems. E. W. Hart and William P. Durtnall. The present article is principally short illustrated descriptions of the various petrol-electric systems that have been tried, introductory to a statement of the advantages of electric transmission. Editorial also. 4500 w. Elec Engr, Lond—Jan. 25, 1907. Serial. 1st part. No. 82140 A.

Radiators.

Honeycomb Radiators—Their Construction. L. Baudry de Saunier. An illustrated study of these radiators as applied on automobiles. 1300 w. Automobile—Jan. 31, 1907. No. 82065.

Rambler.

Ramblers for 1907. Illustrates and describes the improvements introduced in the new models. 1600 w. Automobile—Jan. 31, 1907. No. 82066.

Side Frames.

Importance of Strength in Side Frames. Thomas J. Fay. Discusses the use of alloy steel, giving the characteristics and composition of various steels, and their suitability, or otherwise, for automobile construction. Ills. 2500 w. Automobile—Feb. 7, 1907. No. 82172.

Spyker.

The 30-42 H.P. Spyker Chassis. A car of Dutch origin, remarkable for its smooth running and reliability, is illustrated and described. 1600 w. Autocar—Feb. 2, 1907. No. 82234 A.

We supply copies of these articles. See page 158.

Sturtevant.

The Sturtevant Petrol Car. An American vehicle having an automatic change-speed gear is illustrated and described. 1500 w. Auto Jour—Feb. 2, 1907. No. 82233 A.

Tires.

American Detachable Tires and Removable Rims. C. B. Hayward. An illustrated article reviewing progress in tires, removable rims, and detachable tires. 3300 w. Automobile—Feb. 14, 1907. No. 82299.

Touring Cars.

Bodies, Running Gear and Equipment of Touring Cars (Karosserie, Laufwerk und Ausrüstung von Tourenwagen). Lieut. Herzog. Illus. 2200 w. Zeitschr d Mit Motorwagen Ver—No. 21, Nov., 1906. No. 82303 D.

Traction Engine.

Traction Engine (Motorlastzug). A. Heller. Description of a steam motor driven vehicle for hauling other wagons. Illus. 1300 w. Zeitschr d Vereines Deutscher Ingenieure—Jan. 26, 1907. No. 82362 D.

Two-Speed Gears.

Two-Speed Gears for Motor Bicycles. Rev. Basil H. Davies. Brief discussion of whether two-speed gears are necessary, whether there are any practical devices to be had at the present, and the specifications of a technically perfect gear. 2500 w. Auto Jour—Feb. 9, 1907. No. 82451 A.

Weigel.

The 40-H.P. Weigel Car. Illustrates and describes a British built car erected from various parts manufactured by others. Leading characteristics and dimensions are discussed in this number. 1200 w. Auto Jour—Feb. 2, 1907. Serial. 1st part. No. 82231 A.

COMBUSTION MOTORS.

Alcohol.

Denatured Alcohol: Its Manufacture and Some of Its Uses. Henry Leffmann. Information of interest, with short discussion. 2500 w. Pro Engrs' Club of Phila—Jan., 1907. No. 82548 D.

The Use of Alcohol in Combustion Engines. R. E. Mathot. Considers the development of alcohol engines; the properties of alcohol as a fuel; its advantages and applications. Ills. 3000 w. Engr, U S A—Feb. 1, 1907. No. 82102 C.

Comparison.

Internal Combustion Motors and Steam Engines (Moteurs à Combustion Interne et Machines à Vapeur). R. E. Mathot. A comparison of the two types of prime mover. Comprehensive treatment. Diagrams and tables. 15600 w. Revue de Mécanique—No. 6, Dec. 31, 1906. No. 82319 E + F.

Crank Shafts.

The Weakness of Gas-Engine Crank Shafts. Remarks on the defective designs of gas-engine crank shafts, from an article by J. F. L. Crosland in *Vulcan*. Ills. 900 w. Mech Engr—Feb. 16, 1907. No. 82595 A.

Fuels.

Gasoline, Kerosene, or Alcohol for Marine Explosive Engines. A. E. Potter. Gives a comparison of the heat values of these fuels, discussing their cost and use. 2500 w. Sci Am Sup—Feb. 23, 1907. No. 82581.

Gas Engines.

An Historical Sketch of the Gas Engine. John Hays Hammond, Jr. Brief review of the early history and development, and its application for motive power of automobiles. 2000 w. Yale Sci M—Jan., 1907. No. 82032 C.

Gas-Engine Practice. A discussion of the papers by Prof. H. Hubert, Mr. Tom Westgarth, and Mr. K. Reinhardt. 5000 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82514.

Large Size Gas Engines on the Continent. Dr. Alfred Gradenwitz. Discusses their adaptation to iron works and collieries. Ills. 2800 w. Engr, U S A—Feb. 15, 1907. No. 82433 C.

Körting Gas-Engines at the Shelton Iron Works, Stoke. An account of these works and their output, with a description of the gas-engines installed, which are run with coke-oven gas. Ills. 2700 w. Engng—Feb. 15, 1907. No. 82607 A.

Gas Power.

Large Gas Power Plants. C. E. Douglas. Abstract of a paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Discusses the suitability or otherwise of gas plants for works requiring from 200 to 1,500 b. h.p., their reliability and economy. 4500 w. Ir & Coal Trds Rev—Jan. 25, 1907. No. 82158 A.

The Evolution of Gas Power. Discussion of paper by F. E. Junge. 5000 w. Pro Am Soc of Mech Engrs—Feb., 1907. No. 82503 F.

Governing.

Crossley's Governing Device for Internal-Combustion Engines. Brief illustrated description of an ingenious device for controlling the gas valve with a view to varying the power of the impulses to suit the load on the engine. 1000 w. Mech Engr—Feb. 2, 1907. No. 82238 A.

Indicator.

Petrol Engine Indicating. Illustration and particulars concerning the Schulze monograph and its use. 1500 w. Autocar—Feb. 2, 1907. No. 82236 A.

Silencer.

Kennedy's Silencer for Internal-Combustion Engines. Illustrates several forms

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of a device for cooling and silencing the exhaust gases. 800 w. Mech Engr—Feb. 2, 1907. No. 82239 A.

Suction Gas.

Limitations of Suction Gas Plant. A brief discussion of the minimum and maximum limitations. 1800 w. Elec Rev, Lond—Feb. 1, 1907. No. 82245 A.

The Working of a Suction Gas Plant. Arthur J. Stevens. An illustrated account of the actual working of a small suction gas plant, stating the circumstances and conditions which led to the adoption of this form of power. 2200 w. Min Jour—Jan. 26, 1907. No. 82150 A.

Note on Suction Producer Plant. A. E. Porte. Read before the Dublin Sec. of the Inst. of Elec. Engrs. Considers the heat losses, the fuel, the efficiency, and the fundamental principles on which the suction producer operates, and some of its infirmities. 7800 w. Elec Engr, Lond—Jan. 25, and Feb. 1, 1907. Serial. 2 parts. No. 82244 each A.

Suction Gas Engines and Gas Plants. H. Campbell. Abstract of a paper read before the Leeds Local Sec. of the Inst. of Elec. Engrs. Gives the costs of running gas engines in generating stations, and compares the results with those obtainable by steam plant. Discussion. 4000 w. Elect'n, Lond—Feb. 8, 1907. No. 82459 A.

Suction Gas Engines and Gas Plants. Hugh Campbell's paper on this subject is discussed. Ills. 9000 w. Trans Inst of Engrs & Shipbldrs in Scotland—Dec. 18, 1906. No. 82629 N.

Suction Gas Engines and Gas Plants. Continued discussion of paper by Hugh Campbell. 9900 w. Trans Inst of Engrs & Shipbldrs in Scotland—Jan. 22, 1907. No. 82630 N.

The Use of Suction Gas Producers for Power Purposes. N. T. Harrington. An illustrated description of a suction gas producer, discussing the different classes of work to which it is applicable, performances, etc. 5000 w. Jour Assn of Engng Socs—Jan., 1907. No. 82497 C.

Tests.

Efficiency Tests on a High-Speed Petrol Motor. B. Hopkinson. Describes tests made on a high-speed petrol motor for efficiency, using a new type of indicator which gives correct diagrams at high speeds. 3500 w. Engng—Feb. 8, 1907. No. 82464 A.

Theory.

Explosion and Combustion Motors (Les Moteurs à Explosion et à Combustion. Les Gazogènes). A. Bochet. Theoretical discussion, diagrams. 3900 w. Bulletin de la Société Internationale des Electriciens—No. 60, Dec., 1906. No. 82318 F.

HEATING AND COOLING.

Buildings.

Heating of Large Buildings by Steam and by Hot Water (Die Wärmeversorgung grosser Gebäudekomplexe mit Dampf und Warmwasser). M. Haller. Comparison of economy and effectiveness of the two systems. Diagram. 3600 w. Gesundheits Ingenieur—Jan. 19, 1907. No. 82351 D.

Cooling for Buildings (Abkühlung von Gebäuden). O. Krell. Mathematical discussion of heat interchange between interior and exterior of different kinds of buildings. Diagrams. 6100 w. Gesundheits Ingenieur—Jan. 5, 1907. No. 82350 D.

Hot Blast.

Hot Blast Heating. Charles L. Hubbard. Considers the subject as covering all forms of heating and ventilation where a fan is used for moving the air. 1100 w. Dom Engng—Feb. 16, 1907. Serial. 1st part. No. 82420.

Hot Water.

Quick Circulating Systems of Hot Water Heating. C. Guitton. Read before the Am. Soc. of Heat. and Vent. Engrs. Briefly reviews the principal features of the systems of Reck, Brückner, Hamelle, Koerting, etc., and describes in detail the Rouquaud system, or circulation by fall. 2800 w. Met Work—Feb. 23, 1907. No. 82517.

Plants.

The Heating, Ventilating and Electrical Equipment of the Claflin Building, New York. Illustrated description of the very complete plant for this ten-story and basement steel and brick structure. 5000 w. Eng Rec—Feb. 23, 1907. No. 82524.

Heating and Ventilating Plant of the United Engineering Building, New York. An illustrated detailed description of both supply and exhaust ventilation, and direct and indirect heating. Ills. 4000 w. Eng Rec—Feb. 16, 1907. No. 82417.

Refrigeration.

Ammonia Fittings. J. C. Calhoun. Discusses various designs and the weak points in each, showing the importance of the proper hanging of pipe lines, and discussing related topics. 3300 w. Ice & Refrig—Feb., 1907. No. 82121 C.

Mechanical Refrigeration. J. C. Goosmann. Discusses some of the physical laws that make possible the artificial production of low temperatures. 1500 w. Engr, U S A—Feb. 1, 1907. No. 82101 C.

A Modern Absorption Ice Plant. William S. Luckenbach. Illustrates and describes in detail the planning and installation of a 60-ton plant. 3000 w. Engr, U S A—Feb. 15, 1907. No. 82435 C.

Steam Heating.

The Carrying Capacity of Pipes in Low-Pressure Steam Heating. William

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Kent. Read before the Am. Soc. of Heat. and Vent. Engrs. Gives tables based upon an assumed drop of one pound pressure per 1,000 ft. of length, explaining their use. Discussion. 4000 w. Heat & Vent Mag—Feb., 1907. No. 82614.

Theatre.

Ventilation of the New Theatre in Cologne (Die Lüftung des Neuen Stadttheaters in Köln). Herr Herbst. Description of general method used. 2500 w. Gesundheits Ingenieur—Jan. 5, 1907. No. 82311 D.

HYDRAULICS.

Pumps.

Centrifugal Pumps. Richard C. Williams. An illustrated explanation of their theory, design, and performance. 2200 w. Eng & Min Jour—Feb. 16, 1907. No. 82409.

Modern Pumping and Hydraulic Machinery. Edward Butler. Reviews the development of pumping engines, illustrating and describing early types. 3500 w. Mech Engr—Jan. 26, 1907. No. 82137 A.

Progress in Pumps. Presidential address of Dabney H. Maury before the Illinois Society of Engineers and Surveyors. 2000 w. Eng Rec—Feb. 9, 1907. No. 82229.

MACHINE WORKS AND FOUNDRIES.

Castings.

Brass Castings. J. L. Jones. Read before the Pittsburg Found. Assn. The importance of good molding sand, metal used for brass castings, mixtures, etc. 3500 w. Foundry—Feb., 1907. No. 82271.

Casting Brass on Iron. Louis Luhrsen. Describes a brass bushing cast around a throttle stem for a locomotive. Ills. 1000 w. Foundry—Feb., 1907. No. 82273.

Pattern for a Chilian Mill Mortar. H. J. McCaslin. Illustrates and describes the laying out, construction of the pattern, and molding. 2000 w. Foundry—Feb., 1907. No. 82274.

Crank-Shaft.

Building a Large Crank-Shaft—Some of the Methods Employed. W. Burns. A short description of the tools and methods used in machining and building up of the various parts of a large marine engine crank-shaft. 1500 w. Am Mach—Vol. 30, No. 6. No. 82168.

Drawings.

The Making, Indexing and Filing of Drawings. J. J. Harmon. Read before the Ill. Soc. of Engrs. & Survs. Discusses this subject in detail, describing methods used by different shops. 3300 w. Eng Rec—Feb. 16, 1907. No. 82418.

Electric Driving.

General Adaptation of Electric Motors to Manufacturing Plants. C. H. Darrall. Remarks on the advantages of electric driving, pointing out some valuable features of both the alternating current and direct current systems. 2800 w. Can Soc of Civ Engrs—Jan. 10, 1907. No. 82054 N.

Foundries.

New Plant of the Detroit Steel Casting Co. Illustrates and describes a well-equipped foundry of fireproof construction, where open hearth and converter steel castings are manufactured. 3000 w. Ir Trd Rev—Feb. 14, 1907. No. 82298.

The American Cast Iron Pipe Company's Foundry. Illustrated description of this new plant at Birmingham, Ala. 2500 w. Ir Age—Feb. 7, 1907. No. 82161.

The New Foundries of the Holwell Iron Company, Limited. Illustrated description of new English foundries near Melton Mowbray. 4500 w. Ir & Coal Trds Rev—Feb. 8, 1907. No. 82475 A.

Science in the Foundry. William W. Hearne. Read before the Am. Assn. for the Adv. of Science. Shows why it is necessary for foundrymen to know the analysis of the pig iron or the ore and fuel that are used. 1200 w. Eng News—Feb. 21, 1907. No. 82533.

Furnaces.

Two Novel Heating Furnaces. Illustrated description of two furnaces for tempering small duplicate parts in large quantities. 1000 w. Ir Age—Feb. 14, 1907. No. 82265.

Hammers.

Fairbanks-Morse Pneumatic Hammers. Illustrates and describes a recent patent which was based on an extensive series of experiments. 1000 w. Ir Age—Feb. 14, 1907. No. 82263.

Pneumatic Hammers (Note sur les Frappeurs Pneumatiques). A. Baril. Comprehensive review of the development and construction of these tools and of their manifold uses. Illus. 4700 w. Revue de Mécanique—Jan., 1907. No. 82342 E + F.

Metalworking.

The Census of Metalworking Machinery. Interesting information from a report by F. J. Miller, prepared for the U. S. Census Bureau, covering the production of metalworking machinery in 1904. 4500 w. Ir Age—Feb. 21, 1907. No. 82519.

Oil Furnace.

Melting in an Oil Furnace. F. S. Fasig. An account of the writer's success. 1000 w. Foundry—Feb., 1907. No. 82272.

Patterns.

Metal Patterns. John Magee. Discusses metal patterns for light specialty work. 3000 w. Foundry—Feb., 1907. No. 82275.

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Pipe.

Materials and Properties of Wrought Pipe. F. N. Speller. Discusses certain characteristics possessed by the metals used in the manufacture of modern welded pipe and certain qualities which have widened the field of use for tubular goods. Discussion. Ills. 4000 w. Pro Engrs' Soc of W Penn—Jan., 1907. No. 82044 D.

Planer.

A High-Speed Planer. C. Moody. Illustrated detailed description of a planing-machine 30 in. by 30 in. by 8 ft. 3000 w. Mech Engr—Feb. 16, 1907. No. 82597 A.

Power.

The Choice of Motive Power for the Workshop. Rodolphe Mathot. This third and concluding article of a series gives a comparison of burden costs and a study of working examples. 5400 w. Engineering Magazine—March, 1907. No. 82638 B.

Press Tools.

Sectional Press Tools. Built-up Punch and Die for a Circular Blank with Irregular Opening. R. A. Almond. Considers the designing, construction, and working of these tools. Ills. 1000 w. Am Mach—Vol. 30, No. 6. No. 82169.

Shrinkage.

Shrinkage from a Founder's Point of View. W. Roxburgh. Read at British Found. Assn. Considers shrinkage in metal castings, the warping or twisting due to unequal cooling, and related matters. Ills. 2500 w. Foundry—Feb., 1907. No. 82270.

Testing.

Sankey's Workshop Testing-Machine. Illustrated description of this machine and its operation. 1200 w. Engng—Feb. 15, 1907. No. 82608 A.

Tools.

Some New and Useful Electric Hand Tools. A. Frederick Collins. Various portable hand tools, driven by electricity, are illustrated and described. 1500 w. Sci Am—Feb. 23, 1907. No. 82576.

Car Wheels.

The Manufacture of Cast Iron Car Wheels. An illustrated review of the development of the circular floor, straight line and continuous systems, and the introduction of labor saving equipment. 3000 w. Ir Trd Rev—Feb. 7, 1907. No. 82181.

MATERIALS OF CONSTRUCTION.

Alloys.

Eighth Report to the Alloys Research Committee: On the Properties of Alloys of Aluminium and Copper. Prof. H. C. H. Carpenter and C. A. Edwards. A full report of research carried out by the authors, explaining the scheme, the materials used, and methods. Ills. 38000 w. Inst of Mech Engrs—Jan. 18, 1907. No. 82049 N.

MEASUREMENT.

Air Resistance.

Canovetti's Air-Resistance Experiments. An illustrated account of investigations made by this Italian engineer on the Como Brunate inclined plane. 1200 w. Sci Am—Feb. 23, 1907. No. 82575.

Air Pressure on a Moving Surface (Pression de l'Air sur une Surface en Mouvement. Etude due Coefficient K). J. Rodet. Mathematical treatment. Diagrams. 1900 w. Revue de Mécanique—Jan., 1907. No. 82343 E + F.

Pallograph.

Machine for Recording the Vibration of Ships. Daniel M. Luehrs. Illustrates and describes an invention of E. Otto Schlick, explaining its method of recording. 1800 w. Sci Am—Feb. 9, 1907. No. 82176.

Superheating.

A Dynamical Method of Determining Experimentally the Specific Heat Under Constant Pressure of Superheated Steam. Sydney B. Bilbrough. Describes the practical carrying out of these experiments, also what values can be deduced from the results. 14800 w. Jour of Transvaal Inst of Mech Engrs—Dec., 1906. No. 82055 E.

Tachometer.

Influence of a Tachometer on Governor Regulation (Der Einfluss des Tachometers auf den Reguliervorgang indirekt wirkender Regulatoren). Philipp Ehrlich. Mathematical analysis and treatment of the subject. Diagrams. Serial. 3 parts. 7200 w. Elektrotech und Maschinenbau—Jan. 13, 20 and 27, 1907. No. 82339 D.

Temperature.

Thermometers and Pyrometers. Robert S. Whipple. Address delivered before the Syracuse, N. Y., Chem. Soc. and the Tech. Club. An account of some of their industrial applications. Ills. 5500 w. Ir Age—Feb. 7, 1907. No. 82164.

Venturi Meter.

The Venturi Meter. Illustrates and describes the design, explaining the principle involved. 500 w. Prac Engr—Feb. 15, 1907. Serial. 1st part. No. 82594 A.

POWER AND TRANSMISSION.

Bearings.

Bearings and Their Lubrication. Francis H. Davies. Discusses methods of lubricating, the importance of good lubricating oils, hot bearings, etc. 2000 w. Elec Wld—Feb. 2, 1907. No. 82134.

Cranes.

A 150-Ton Giant Crane. Illustrated

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detailed description of a large crane for harbor work, built at British works, with some reference to German types. 2500 w. Engr, Lond—Feb. 1, 1907. No. 82260 A.

Electrically-Driven Transportable Gantry Cranes of 4,000 KG. Lifting Power, with Patented Universal Discharging Device. Illustrated description of a crane for the Cologne-Deutz harbor. 1100 w. Prac Engr—Feb. 1, 1907. No. 82593 A.

Overhead Travelling Revolving Foundry-Crane. Illustrated description of a new type of crane as regards the application and method of working, built in Nuremberg. 500 w. Engng—Jan. 25, 1907. No. 82155 A.

Electric Cranes at the Nuremberg 1906 Exposition (Die Bayerische Jubiläums-Landes-Ausstellung in Nürnberg 1906). A. Hundt. Description of jib and traveling cranes, with diagrams of the wiring. Illus. 1900 w. Elektrotech Zeitschr—Jan. 31, 1907. No. 82332 B.

Electric Driving.

Electrical Equipment of the West Virginia Pulp and Paper Company, Piedmont, W. Va. Illustrated description of the conversion of a plant from steam to electric power without interruption of service. 3500 w. Elec Wld—Feb. 9, 1907. No. 82197.

Electrically-Driven Rolling Mills. Abstract of a paper by G. M. Brown, before the Rugby Engng. Soc. Discusses the application of electricity to the exacting work of driving main rolls, examining the mechanical features of the problem and the various methods by which electric driving has been made practically and commercially feasible. Ills. 3800 w. Elec Engr, Lond—Feb. 1, 1907. Serial. 1st part. No. 82243 A.

Elevators.

Test of a Plunger Elevator Plant. Discussion of paper by A. J. Herschmann. Ills. 6200 w. Pro Am Soc of Mech Engrs—Feb., 1907. No. 82504 F.

Power Plant.

The Planning and Construction of the Power Plant. A. E. Dixon. This seventh, and last, article of Mr. Dixon's series deals with the design and arrangement of the central station building, giving illustrations of recent work. 3800 w. Engineering Magazine—March, 1907. No. 82634 B.

STEAM ENGINEERING.

Blowing Engine.

A Novel Blowing Engine. An illustrated description of the Nordberg blowing engine, which has an entirely new positive valve motion giving extra large valve areas. 2200 w. Am Mach—Vol. 30, No. 6. No. 82165.

Boilers.

A Comparison of Boiler Types. M. T. Goss. Discusses the best type of boiler for efficiency and maintenance, aiming to give suggestions to develop steam power for less cost. 2200 w. Min Rept—Feb. 21, 1907. No. 82563.

Steam Boilers. Angus Sinclair. From "Development of the Locomotive Engine." States the principal requisites of a well-designed boiler, considering briefly various forms, and the modern firebox. 1600 w. Ry & Loc Engng—Feb., 1907. No. 82125 C.

Testing Boilers. Methods of finding efficiency, horse-power and evaporation per pound of coal. Ills. 2000 w. Engr, U S A—Feb. 15, 1907. No. 82434 C.

Boiler and Setting. Discussion of paper by A. Bement on this subject. 4500 w. Pro Am Soc of Mech Engrs—Feb., 1907. No. 82505 F.

Specifications for a Three-Furnace Single-Ended Scotch Boiler. Gives a typical set of specifications representing the best marine boiler construction at the present time. Ills. 4500 w. Boiler Maker—Feb., 1907. No. 82128.

The Temperley-Cockburn Boiler. Illustrates and describes a new system of working water-tube boilers, which aims to secure additional output and efficiency. 3000 w. Engng—Feb. 8, 1907. No. 82467 A.

Boilers in London Electric Stations (Die Dampfkessel in den Elektrizitätswerken Londons). R. Lind. Enumeration and description of different kinds and sizes of boiler in use. Illus. 5200 w. Zeitschr d Vereines Deutscher Ingenieure—Jan. 12, 1907. No. 82358 D.

Coal Tests.

Illinois Coal Tests. Henry B. Dirks. Read before the Illinois Soc. of Engrs. & Survs. A report of tests made of these coals for their heat value, and for their adaptability to power-gas production, and on the washing and coking of coals. 2000 w. Eng Rec—Feb. 23, 1907. No. 82523.

Testing and Purchasing Coal for Steam Plants. A. O. Doane. Discusses methods of sampling and testing coal and the advantage of frequent tests to large consumers. 3500 w. Eng News—Feb. 7, 1907. No. 82184.

Condensers.

Condenser Piping for Steam Turbines (Zentralkondensationen zum Anschluss von Dampfturbinen). Herr Stach. Illus. 3800 w. Glückauf—Dec. 22, 1906. No. 82321 D.

Cooling Towers.

Cooling Tower Practice. Jos. H. Hart. Explains the usefulness of cooling towers, their object, reliability, durability, cost,

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etc. 1700 w. Elec Rev, N Y—Feb. 16, 1907. No. 82406.

Engine.

Tandem Valve Steam Engine (Tandem-Ventildampfmaschine, Bauart Lentz). Karl H. Merk. Engine with Lentz valves. Illus. 800 w. Zeitschr d Vereines Deutscher Ingenieure—Jan. 26, 1907. No. 82363 D.

Feeding Systems.

Boiler Feed-Piping. R. T. Strohm. Considers feed-water systems and matters relating to them. Ills. 2000 w. Elec Wld—Feb. 2, 1907. No. 82133.

Governor.

New Speed Governor (Neuere Geschwindigkeitsregler). Ferd. Strnad. Description of a new type of inertia governor for steam engines. Serial. 2 parts. 5000 w. Illus. Zeitschr d Ver Deutscher Ing—Jan. 5 and 12, 1907. No. 82357 each D.

Inspection.

Construction Inspection of Boilers and Engines. J. R. Thompson. The present article deals with the inspection of boiler work through all the stages of construction. Ills. 3800 w. Cassier's Mag—Feb., 1907. Serial. 1st part. No. 82285 B.

Smoke.

Smoke Prevention in the Power House. C. H. Benjamin. Explains why smoke abatement saves fuel, and the value of the mechanical stoker for securing good combustion, illustrating and describing types. 2200 w. Cassier's Mag—Feb., 1907. No. 82286 B.

Specific Heat.

Influence of Pressure and Temperature on the Specific Heat of Steam (Die Abhängigkeit der spezifischen Wärme Cp des Wasserdampfes von Druck und Temperatur). O. Knoblauch and Max Jakob. Comprehensive account of recent determinations of this constant. Illus. Serial. 2 parts. 9900 w. Zeitschr d Vereines Deutscher Ingenieure—Jan. 19 and 26, 1907. No. 82361 each D.

Superheating.

Present Practice in the Use of Superheated Steam. Reginald Pelham Bolton. A review of American engineering practice during the last ten years in this field, the progress and the economy effected. 3300 w. Engineering Magazine—March, 1907. Serial. 1st part. No. 82635 B.

Turbines.

900 Horse-Power Turbine for India. Illustrated description of one of the most powerful turbines yet made. 800 w. Engr, Lond—Feb. 8, 1907. No. 82473 A.

The Development and Present Status of the Steam Turbine in Land and Marine Work. Discussion of E. M. Speakman's paper. 3000 w. Trans Inst of Engrs & Shipbldrs in Scotland—Dec. 18, 1906. No. 82628 N.

Steam Turbines with Jet Condensers (Dampfturbinen mit Einspritzkondensation). F. Niethammer. 600 w. Zeitschr für das Gesammte Turbinenwesen—Jan. 10, 1907. No. 82365 D.

Valve Gears.

Some Leading Types of Valve Gears. Illustrated detailed descriptions of various types. 1600 w. Mech Engr—Feb. 16, 1907. Serial. 1st part. No. 82596 A.

Guided Valve Gear for Poppet Valves (Zwangläufige Ventilsteuerung mit Flachregler). R. Proell. Analytical discussion of valve arrangements for steam engines. Illus. 4800 w. Zeitschr d Ver-Deutscher Ing—Jan. 26, 1907. No. 82364 D.

Water Softening.

Notes on Water Softening. W. D. Collins. Read before the Indiana Engng. Soc. Gives results of experimenting with different methods, explaining the methods of determining the constituents. 2500 w. Eng Rec—Feb. 16, 1907. No. 82412.

MISCELLANY.

Aeronautics.

Aërial Locomotion with a Few Notes of Progress in the Construction of an Aërodrome. Alexander Graham Bell. An address before the Washington Acad. of Sci. An illustrated review of work accomplished with flying machines, especially the writer's experiments with kites. 8500 w. Nat Geog Mag—Jan., 1907. No. 82046 C.

Progress in Airships. Forms of Gas Bags. Carl E. Myers. Points out defects in the construction of gas bags and reviews some experiments in aeronautics made by the writer. 1600 w. Sci Am Sup—Feb. 9, 1907. No. 82180.

Recent Progress in Aërial Navigation. J. D. Fullerton. A discussion of dirigible ballooning, or navigation by machines lighter than air, and aviation, or navigation by machines heavier than air, giving a list of journals containing useful information on aërial navigation. Ills. 17800 w. Jour Ry U S Inst—Jan., 1907. No. 82048 E.

The Flights of Zeppelin's Airship on October 9 and 10, 1906. An illustrated account of these trials. 1600 w. Sci Am Sup—Feb. 23, 1907. No. 82580.

Aeroplane.

The Tani Aeroplane Model. Illustrated detailed description of an original idea for obtaining mechanical flight. 1500 w. Auto Jour—Feb. 16, 1907. No. 82586 A.

Air Compressors.

Piston Compressors and Turbo-compressors (Kolbenkompressor und Turbokompressor). E. W. Köster. Discussion of the relative advantages of the two kinds. Tables. 1900 w. Glückauf—Dec. 29, 1906. No. 82322 D.

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Dynamics.

On Simplicity of Method in Elementary Dynamics. E. V. Huntington. Gives easily remembered working rules or principles, showing, by examples, how ordinary problems can be solved by reference to them. 2200 w. Harvard Engng Jour—Jan., 1907. Serial. 1st part. No. 82620 D.

Energy.

Conversion of Energy and Dynamics of Muscular Force. J. E. Siebel. A review of the fundamental laws of heat energy and its conversion into motion; the animal organism as a basis for study of electrical energy; energy conversion by means of electric battery that has its counterpart in the muscular system. Ills. 3200 w. Ice & Refrig—Feb., 1907. No. 82120 C.

Engineering Building.

The New Engineering Building and Equipment of the University of Pennsylvania. Illustrated detailed description. 4500 w. Pro Engrs' Club of Phila—Jan., 1907. No. 82549 D.

Equilibrium.

The Equilibrium of Least Stability in a Non-Rigid System (Sull' equilibris di minima stabilità dei sistemi deformabili). A. Ciappi. Mathematical paper, diagrams. 5300 w. Annali della Societa degli Ingegneri e degli Architetti Italiani—No. 2, 1906. No. 82313 D.

Guns.

A New Vickers Automatic Rifle-Calibre Gun. Illustrates and describes a new Vickers gun intended for naval and field use. 4500 w. Engng—Jan. 25, 1907. No. 82154 A.

Inflammable Liquids.

Storage of Inflammable Liquids (Die Lagerung feuergefährlicher Flüssigkeiten). Herr Reichel. Methods described for storing benzine and gasoline so as to diminish fire risk. Illus. 3600 w. Zeitschr d Mit Motorwagen Ver—No. 24, Dec., 1906. No. 82308 D.

MINING AND METALLURGY

COAL AND COKE.

By-Products.

Coke-Oven Recovery Products in 1906. Reports in regard to sulphate of ammonia, pitch, carbolic acid, naphthas, and benzols. 1800 w. Col Guard—Feb., 1907. No. 82251 A.

China.

Coal Mining in China. Noah Fields Drake. An account of the crude methods still used for mining, and a discussion of the various mines being developed. Ills. 1800 w. Min Wld—Feb. 16, 1907. No. 82446.

Coal Mining.

Early Coal Mining in the Lackawanna Valley. William H. Richmond. A history of the development of the mining and transportation industries. 2000 w. Mines & Min—Feb., 1907. No. 82111 C.

Coal, Origin, Formation, and Methods of Mining. P. Y. Cox. A short paper followed by an illustrated description of an underground trip and of other features of coal mining in Pennsylvania. 4000 w. Pro Ry Club of Pittsburgh—Nov., 1906. No. 82490 C.

Our Coal. F. Z. Schellenberg. Describes the bituminous deposits of Western Pennsylvania, the methods of mining, ventilation, and related matters of interest. Also discussion. 7500 w. Pro Engrs' Soc of W Penn—Jan., 1907. No. 82045 D.

A Single-Room System of Mining. H. S. Gay. Read before the Coal Min. Inst. of America. Explains an adaptation of the Longwall method to work in thick seams. Ills. 3300 w. Mines & Min—Feb., 1907. No. 82115 C.

The Use of Electricity in Anthracite Mining. H. M. Warren. Illustrates and describes modern equipment, comparing its advantages with obsolete methods. Refers particularly to improvements made in the coal-mining department of the Lackawanna Railroad. 1000 w. Eng & Min Jour—Feb. 2, 1907. No. 82098.

Coke.

The Coke Supply of the United States. Edward W. Parker. A description of present and future sources. Map. 5500 w. Ir Age—Feb. 7, 1907. No. 82163.

Coke Ovens.

Coke Oven Materials. J. M. McKinley. Read before the Coal Min. Inst. of America. Discusses the behavior of coke-oven brick made of different materials and in varying proportions. 2000 w. Mines & Min—Feb., 1907. No. 82113 C.

Disasters.

Causes and Prevention of Disasters in Mines. G. Farmer. Colliery disasters are especially considered, their causes, and means of lessening the danger. 4400 w. Cassier's Mag—Feb., 1907. No. 82282 B.

Fires.

Coal Mine Fires. R. V. Norris. Considers the causes, the precautions to be observed, and successful methods of attack. 2500 w. Eng & Min Jour—Feb. 9, 1907. Serial. 1st part. No. 82194.

Gases.

The Action of Coal-mine Gases. Rich-

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ard Lee. Briefly explains the effects of breathing carbon monoxide, fire-damp, and after-damp. 900 w. Eng & Min Jour —Feb. 9, 1907. No. 82195.

Haulage.

Underground Haulage. T. Nevin. Describes endless rope and endless chain haulage systems in use in British coal mines. 2000 w. Min Wld—Feb. 9, 1907. No. 82213.

Illinois.

Coal Mining in Eastern Illinois. F. W. Parsons. Illustrated description of details of equipment, and methods employed by The Dering Coal Company. 1400 w. Eng & Min Jour—Feb. 16, 1907. No. 82410.

Lignite.

Lignite of Northeastern Wyoming. Stewart Kennedy. Describes extensive coal fields being rapidly opened along the C. B. & Q. Railroad. Ills. 2500 w. Mines & Min—Feb., 1907. No. 82110 C.

Michigan.

Coal Mining in Michigan. George E. Edwards, A report of the coal deposits, methods of mining, development, etc. 2000 w. Min Wld—Feb. 9, 1907. No. 82214.

Production.

Mining Statistics. E. W. Parker. Read before the Coal Mining Inst. of America. Statistics in regard to the production of coal, showing the great increase in tonnage in recent years. 1800 w. Mines & Min—Feb., 1907. No. 82112 C.

South Africa.

A Comparison of Certain South African Coals. Interesting comparative data from a paper by F. A. D. Moseley concerning the coals of Natal and Middelburg, Transvaal. 1200 w. Engr, Lond—Feb. 8, 1907. No. 82474 A.

Submarine Mines.

Submarine Coal Mining in Cape Breton. W. P. Deppe. An illustrated article giving a short description of the workings of the Mabou mines. 1400 w. Ry Age—Feb. 22, 1907. No. 82561.

Virginia.

The Richmond Coal Basin. Edward K. Judd. Describes the deposits of this field in Virginia, giving brief history of the development. 1400 w. Eng & Min Jour—Feb. 9, 1907. No. 82196.

COPPER.

Alaska.

Copper Prospects of Prince William Sound. U. S. Grant. From Bul. of the U. S. Geol. Survey. A report on the ores of the district and the development work. 500 w. Eng & Min Jour—Feb. 2, 1907. No. 82094.

Analysis.

Analysis of Industrial Copper. Messrs. Hollard & Bertiaux. Trans. from *Bul. de la Soc. Nat. pour l'Encour. de l'Ind.* Describes details of operation, dealing with impurities separately. 3000 w. Min Jour—Feb. 9, 1907. No. 82462 A.

Arizona.

Copper Mining at Bisbee, Arizona. Robert B. Brinsmade. Gives the history of the discovery and development, describing the formations, methods of mining, and mechanical equipment of the principal plants. 6000 w. Mines & Min —Feb., 1907. No. 82109 C.

Mattes.

Relative Elimination of Iron, Sulphur, and Arsenic in Bessemerizing Copper-Mattes. E. P. Mathewson. A record of experiments made at Anaconda, Mont., for the purpose of determining the relative speed of elimination of the iron, sulphur and arsenic during the process of bessemerizing copper-mattes. 600 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82507.

Nevada.

Mining Conditions at Ely, Nevada. Edward W. Ralph. A report of recent development of the sulphide copper deposits, and remarks on the conditions at the present time. Map and geological section. 1400 w. Min & Sci Pr—Jan. 26, 1907. No. 82069.

The Copper Deposits of the Robinson Mining Districts of Nevada. Andrew C. Lawson. A description of the geological formation of these deposits. 1100 w. Min Rept—Feb. 14, 1907. No. 82441.

Sulphides.

The Constitution of Ferro-Cuprous Sulphides. H. O. Hofman, W. S. Caypless, and E. E. Harrington. An investigation intended to supplement the paper of A. Gibb and R. C. Philp, on "The Constitution of Mattes Produced in C per Smelting," by drawing the freezing-point curve of the series ferrous sulphide cuprous sulphide, and seeing how the constitution could be further revealed by microscopic work. Ills. 3000 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82509.

GOLD AND SILVER.

Arsenides.

Roasting of the Argentiferous Cobalt-Nickel Arsenides of Temiskaming, Ontario, Canada. Henry M. Howe, William Campbell, and Cyril W. Knight. Gives results of an investigation of their behavior in roasting, aiming to determine the temperature at which the arsenic is most rapidly expelled, the thoroughness of prolonged roasting, the effect of adding charcoal near the end and at the beginning of the roast. 1800 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82511.

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The Treatment of Arsenical Ores. Chester F. Lee. Concerning the Cascade arsenical-gold ores and their treatment. 1200 w. Can Min Rev—Feb., 1907. No. 82440 B.

Assay.

The Assay of Silver Bullion by Volhard's Method. Ernest A. Smith. Describes this method showing that it is more accurate than the Gay-Lussac method, though not likely to supersede it for commercial bullion assays. 2000 w. Inst of Min & Met, Bul 28—Jan. 10, 1907. No. 82624 N.

Australia.

Geology and Mining at Broken Hill. Ralph Stokes. Describes the rocks and ores, and the mining and timbering methods now employed. Ills. 2800 w. Min Wld—Feb. 23, 1907. No. 82564.

Industrial Conditions at Broken Hill. Ralph Stokes. An illustrated account of this silver-lead district, describing the deposits, and giving information concerning the production, development, etc. Ills. 2000 w. Min Wld—Feb. 16, 1907. No. 82447.

Individual Records of Kalgoorlie Producers. Ralph Stokes. Review of the profitable producers and their methods of mining. Ills. 1700 w. Min Wld—Feb. 2, 1907. No. 82119.

Metasomatic Processes in the Gold Deposits of Western Australia. Waldemar Lindgren. Describes the geological aspects of the country, the occurrence of the gold-bearing lodes, and the associated minerals, calling attention to points in the history of these deposits. 2000 w. Min Jour—Feb. 2, 1907. Serial. 1st part. No. 82249 A.

California.

Geology of the Exposed Treasure Lode, Mojave, California. Courtenay De Kalb. Describes the character of the changes found in the deeper levels of this gold mine of Southern California, and studies the causes and geology of the region. Ills. 3500 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82508.

Cobalt.

The Cobalt District, Ontario. H. W. Hardinge. Describes this mining district and its development. 1700 w. Min Wld—Feb. 9, 1907. No. 82212.

Cobalt Mining in Canada. Allan Porter. An account of this new mining region and its methods. Silver has been the principal output, but there is a high percentage of cobalt, some gold, arsenic, nickel, galena, copper, and other minerals of value. 2000 w. Sci Am—Feb. 2, 1907. No. 82084.

The Nipissing and Foster-Cobalt Mines. Reginald Meeks. An illustrated description of these silver mines, the methods of mining, character of ore, etc. 2200 w. Eng & Min Jour—Feb. 9, 1907. No. 82191.

Cyanidation.

The Cyanidation of Raw Pyritic Concentrates. Frank C. Smith. Describes the local and economic conditions at the mines of the Socorro Gold Co., Yuma Co., Arizona, and the results of a study of the treatment needed for these ores. 2000 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82506.

Cyanide Practice on Boulder County Ores. Frank Leonard. Describes methods at the Cash mill in Magnolia, showing that the cyanide process can be used successfully with this class of ores. 2000 w. Min Rept—Feb. 14, 1907. No. 82442.

The Bullfrog Cyanide Mill. An illustrated description of the new mill which is being erected at Bullfrog, Nevada. 900 w. Eng & Min Jour—Feb. 23, 1907. No. 82568.

The Butters Cyanide Plant, Virginia City, Nev. Claude T. Rice. Illustrated description of a gold-extraction mill equipped with important labor-saving devices. 2500 w. Eng & Min Jour—Feb. 9, 1907. No. 82190.

Gold-Milling.

Design and Working of Gold-Milling Equipment, with Special Reference to the Witwatersrand. George Alfred Denny. Describes a high-speed stamp-mill and its action, and the various machines used, devices and methods, general reduction and treatment scheme, etc. 2 plates and Ills. 18000 w. Inst of Civ Engrs—No. 3623. No. 82039 N.

Guanajuato.

The Big Shafts of Guanajuato. T. A. Rickard. Describes the surrounding country and especially the four great shafts and the work of unwatering of the San José shaft, giving an interesting account of ancient methods. Ills. 3000 w. Min & Sci Pr—Feb. 9, 1907. No. 82445.

Idaho.

South Mountain, Idaho. Robert N. Bell. Describes this silver-lead property, giving sections. 1200 w. Eng & Min Jour—Feb. 9, 1907. No. 82193.

Mexico.

Mining Conditions in the Mountains of Chihuahua. John B. Farish. Illustrates and describes the Dolores mine and mill, and explains the difficulties of operation in the Sierra Madre. 4000 w. Eng & Min Jour—Feb. 2, 1907. No. 82092.

Old Mexican Methods. Bernard MacDonald. Illustrations and notes giving an idea of past methods used to win the silver from the ores. 700 w. Min & Sci Pr—Jan. 26, 1907. No. 82070.

Occurences.

Some Associations of Gold with Pyrite and Tellurides. Drawings and notes

on occurrences showing the relations between gold and pyrite in quartz veins. 1500 w. Min & Sci Pr—Jan. 26, 1907. No. 82068.

Ore Dressing.

Ore Dressing at Broken Hill. G. D. Delprat. Part of a presidential address before the Australian Inst. of Min. Engrs. describing the equipment for concentrating and preparing ores for smelting. Ills. 4200 w. Eng & Min Jour—Feb. 16, 1907. Serial. 1st part. No. 82408.

Placers.

A Mining Enterprise in Colombia. Francis C. Nicholas. Illustrated description of gold placer deposits remarkable both for their high values and for peculiarities of formation. 2000 w. Min Wld—Feb. 9, 1907. No. 82210.

Rolled Silver.

The Manufacture of Rolled Sterling-Silver. Erwin S. Sperry. An interesting article giving an illustrated detailed description of present methods. 5000 w. Jour Fr Inst—Feb., 1907. No. 82061 D.

Siberia.

Gold Mining in Central Siberia. An interview with W. A. Mercer, who has made many prospecting expeditions in Siberia. 4000 w. Min Jour—Feb. 16, 1907. No. 82604 A.

Siberian Proprietary Mines, Limited. Considers the properties in detail. 4000 w. Min Jour—Feb. 16, 1907. No. 82605 A.

Slimes.

A Siphon Device for Removing Floating Material. Edward S. Wiard. Illustrates and describes a device for removing slime, and also suggestive of a means of reducing the volume of water flowing through a tank. 700 w. Min & Sci Pr—Feb. 2, 1907. No. 82208.

The Butters Slime-Filter at the Cyanide Plant of the Combination Mining Company, Goldfield, Nev. Mark R. Lamb. An illustrated description of this filter and its use. 2000 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82513.

The Butters Filter. Mark R. Lamb. Illustrated description of this filter and its operation. 500 w. Min & Sci Pr—Feb. 2, 1907. No. 82207.

The Ridgway Filter. Illustrated description of an invention for treating slime containing gold in solution. 1600 w. Min & Sci Pr—Feb. 9, 1907. No. 82444.

Smelting.

Smelting Chloride of Silver. Describes two methods used for obtaining metallic silver in its chloride, giving the advantages of each. Ill. 1200 w. Brass Wld Feb., 1907. No. 82555.

South Africa.

New Brighton Mines, Limited. Report of a visit by C. S. Edmondson, who has specially examined the Bendigo alluvial gold field in South Africa. 3500 w. Min Jour—Feb. 2, 1907. No. 82250 A.

Tube-Mills.

Grinding in Tube-Mills at the Waihi Gold-Mine, Waihi, New Zealand. E. G. Banks. Gives records of working extending over a lengthy period. 1400 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82512.

IRON AND STEEL.

Blast Furnace.

The Lackawanna Steel Co.'s New Furnace. Illustrated detailed description, with history of the erection of stack No. 7, at Buffalo, N. Y. A record of rapid construction and the solution of interesting engineering problems. 2500 w. Ir Trd Rev—Feb. 21, 1907. No. 82518.

The New Blast Furnace Plant of the Frodingham Iron and Steel Company. Illustrated detailed description. 3500 w. Ir & Coal Trds Rev—Jan. 25, 1907. No. 82159 A.

Blast-Furnace Gas.

The Utility of Cleaning Blast Furnace Gas. H. G. Scott. Abstract of a paper read before the Cleveland Inst. of Engrs. and of the discussion. Describes the method of cleaning the gas, the results, and cost. 2500 w. Min Jour—Jan. 26, 1907. No. 82151 A.

Cast Iron.

Cast Iron. E. Adamson. Discusses the effect of temperature on the chemistry of cast iron, grading by fracture, the influence of sulphur, phosphorus, manganese, and other constituents. Plate. 8000 w. Jour W of Scotland Ir & St Inst—Nov., 1906. No. 82621 N.

Charging.

Charging Furnaces by American Methods (Le Chargement des Hauts Fourneaux d'après les méthodes américaines). Ch. Dantin. Description of mechanical conveyors of American design used in France. Illus. 1700 w. Le Génie Civil—Jan. 19, 1907. No. 82324 D.

Electric Smelting.

See Electrical Engineering, Electro-Chemistry.

Furnaces.

The Efficiency of Furnaces. Dr. Joseph W. Richards. Considers thermal efficiency, both absolute and relative, and also discusses economic efficiency as related to minimum cost. 3500 w. Jour Fr Inst—Feb., 1907. No. 82062 D.

Gogebic.

Some Gogebic Mines as Seen in 1906. Gives a comparison of the output of the active mines, and an illustrated description of some of the methods of mining,

and facts of general interest. 3800 w. Ir Trd Rev—Jan. 31, 1907. No. 82064.

Metallurgy.

Unsolved Problems in Metallurgy. Robert Abbott Hadfield. "James Forrest" lecture. Deals especially with the modern metallurgy of iron and steel, its problems and means of solving them. 12000 w. Inst of Civ Engrs—May 2, 1906. No. 82033 N.

The Iron Mines at Cornwall, Pennsylvania. Prof. William E. Ford. An illustrated article giving the location and history of these mines, describing the deposits, methods of mining, and other matters of interest. 1400 w. Yale Sci M—Jan., 1907. No. 82031 C.

Smelting.

Alabama Iron Manufacture. John J. Porter. Discusses possible economies in the blast furnace. 2500 w. Ir Age—Feb. 7, 1907. No. 82162.

Steel Making.

Making Open Hearth Steel at Pueblo. Lawrence Lewis. The basic and acid furnaces at the Colorado Fuel and Iron Company's Steel Works are illustrated and described. 3300 w. Eng & Min Jour—Feb. 23, 1907. No. 82567.

Steel Making at Pueblo. Lawrence Lewis. Illustrates and describes the reconstructed plant of the Colorado Fuel & Iron Co., its equipment and capacity. 2000 w. Eng & Min Jour—Feb. 2, 1907. No. 82096.

Steel Plates.

Manufacture of Steel Plates (La Fabrication des Plaques de Blindage aux Forges nationales de la Chaussade). A. Bizot. Description of processes of manufacture. Illus. 2800 w. Le Génie Civil—Jan. 26, 1907. No. 82326 D.

Steel Works.

The Krupp Works. The present number gives an illustrated description of the Essen Works. 1800 w. Engr, Lond—Feb. 8, 1907. Serial. 1st part. No. 82472 A.

MINING.

British Columbia.

British Columbia in 1906. Arthur Wheeler, Jr. A review of the tonnage and value of the ores mined during the year, dealing with districts. 4000 w. Can Min Rev—Feb., 1907. Serial. 1st part. No. 82439 B.

Concentration.

Concentration. Fritz Cirkel. Address before the Min. Soc. of McGill Univ. on the problems of extraction, concentration and ore treatment. 4500 w. Can Min Rev—Feb., 1907. No. 82438 B.

Dredging.

Dredging and Horticulture. D'Arcy Weatherbe. Gives results of investigations made of facts relating to rendering the land unfit for agriculture by dredging débris. 1000 w. Min & Sci Pr—Feb. 2, 1907. No. 82206.

Drills.

Diamond Drills. James Humes. Explains their utility for underground exploration. 1000 w. Eng & Min Jour—Feb. 23, 1907. No. 82570.

Electric Power.

The Electric Power Installation at Grangesberg Iron Mines, Sweden. G. Ralph. Read before the Newcastle Sec. of the Inst. of Elec. Engrs. Illustrated description of the electric mining plant installed. 3000 w. Elec Engr, Lond—Feb. 15, 1907. No. 82599 A.

Estimation.

Development Results vs. Stope Results. E. H. Garthwaite. Gives a comparison of results. 500 w. Inst of Min & Met, Bul 29—Feb. 14, 1907. No. 82626 N.

Haulage.

Yak and Newhouse Tunnels. An illustrated article describing the use of Goodman locomotives for underground haulage in these tunnels. 3000 w. Ores & Metals—Jan. 20, 1907. No. 82091.

Hoisting.

Hoisting in Small Zinc Mines in Wisconsin. George S. Brooks. Discusses the merits of cage-car and tub systems, giving a comparison of costs. 1500 w. Eng & Min Jour—Feb. 23, 1907. No. 82569.

Electrical Winding Plants. Alfred Gradenwitz. An illustrated article giving details of arrangements, with descriptions of several German plants. 2200 w. Eng & Min Jour—Feb. 2, 1907. No. 82097.

Electric Windlass (Elektrisch betriebene Spille). Erich Herrmann. Description of motor driven windlasses as used in Europe. Illus. 1700 w. Elektrotech Zeitschr—Jan. 17, 1907. No. 82333 B.

Kaolin.

Kaolin Mining in Georgia. Otto Veatch. The deposits, method of mining and preparation for market are described. Ills. 1100 w. Eng & Min Jour—Feb. 9, 1907. No. 82192.

Mining Terms.

Spanish-American Mining Terms. H. E. West. An explanation of some of the common words and phrases used in mining regions of Central America. 1800 w. Min & Sci Pr—Feb. 2, 1907. No. 82209.

Mistakes.

Mistakes in the Design of Mining and Reduction Plants. S. A. Worcester. Calls attention to mistakes noted, especially describing certain installations observed. 2000 w. Min & Sci Pr—Feb. 2, 1907. No. 82205.

Potash Works.

The Two-Shaft System for Prussian Potash Works. Robert Grimshaw. States

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the advantages claimed for the two-shaft system, and explains the proposed law requiring this system, which is soon to be discussed by a mixed commission. 600 w. Eng & Min Jour—Feb. 2, 1907. No. 82095.

Prospecting.

Prospecting for Rare Minerals and Earths. George E. Walsh. Some suggestions of the value of deposits of tungsten, vanadium, molybdenum, etc. 2000 w. Min & Sci Pr—Feb. 16, 1907. No. 82552.

Pumping Plant.

Electrically-Driven Centrifugal Pumping Plant at the Tywarnhaile Mine. W. R. Thomas. A general description of an installation applied to the unwatering of this mine in Cornwall. 3000 w. Inst of Min & Met, Bul 29—Feb. 14, 1907. No. 82625 N.

Rescue Apparatus.

Breathing Masks and Helmets. W. G. Fitz-Gerald. Illustrates and describes the curious apparatus made for use in mines, collieries, gas and chemical works, fire brigades, sewerage works, ships' coal bunkers, and many other industrial concerns, where self-contained breathing apparatus is needed. 1800 w. Sci Am—Feb. 2, 1907. No. 82086.

Safety Measures.

Safety Measures in Mining. Donald Macaulay and Louis G. Irvine. Reply to discussion of papers by these authors. 13600 w. Jour of Chem, Met, & Min Soc of S Africa—Dec., 1906. No. 82544 E.

Sampling.

Some Sampling Results. E. H. Garthwaite. Discusses the question of proper distance between mine samples, especially for gold reefs, giving methods used and results obtained in Rhodesia. 1500 w. Inst of Min & Met, Bul 28—Jan. 10, 1907. No. 82623 N.

Shafts.

Electrically Operated Sinking-Plant. Trans. abstract of article by W. Philippi, in *Elektrotechnische Zeitschrift*. Illustrated description of the plant recently installed at the Wilhelmina Pit, near Haarlem, as typical of this class of work. 900 w. Elec Rev, Lond—Jan. 25, 1907. No. 82142 A.

Refrigeration for Shaft Sinking. Richard Stetefeld. A comparison of the new Oetling freezing shield process with the older Poetsch method, giving comparative cost. Ills. 1800 w. Ice & Refrig—Feb., 1907. No. 82122 C.

Siberia.

Mining on the Kirghese Steppes. H. E. West. An illustrated account of an interesting trip through Southern Siberia, describing the conditions found, the ancient and modern mines, the deposits, etc. 2500 w. Eng & Min Jour—Feb. 23, 1907. No. 82566.

Sulphur.

Sulphur Mining and Refining in Wyoming. L. W. Trumbull. Describes the deposits and the apparatus and methods used in handling and preparing for market. Ill. 1600 w. Mines & Min—Feb., 1907. No. 82114 C.

Timber.

Timber Used in Metal Mines. R. S. Kellogg. Abstract of Circular 49, U. S. Dept. of Agri., giving tables showing the kind and quantity of timber used in mines of precious metals and of iron. 800 w. Min Wld—Feb. 9, 1907. No. 82211.

MISCELLANY.

Crystals.

Modern Theories of Crystal Structure (Les Théories Modernes Sur La Structure Des Mileux Cristallisés). G. Wyrouboff. 8100 w. Revue Générale des Sciences—Dec. 30, 1906. No. 82312.

Deutschman's Cave.

Deutschman's Cave, Near Banff, B. C., Canada. W. S. Ayres. Map., illustrations, and description of this cavern, discovered Oct. 22, 1904. 4200 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82515 C.

Diamonds.

A Visit to the De Beers Consolidated Diamond Mines. Edgar P. Rathbone. Brief description of methods, mechanical and labor-saving appliances, observed during a recent visit. 1700 w. Inst of Min & Met, Bul 28—Jan., 1907. No. 82622 N.

Himalayas.

Minerals and Metalliferous Lodes of Kulu and Lahaol, Kangra District, Punjab Himalayas. F. C. Hughes. Information in regard to the geology and mineral deposits. Iron, galena, and sapphires were found in Kulu; gold, silver-lead ores, and other minerals in Lahaol. 1500 w. Inst of Min & Met, Bul 29—Feb. 8, 1907. No. 82627 N.

Lime-Roasting.

Laboratory Experiments in Lime-Roasting a Galena Concentrate with Reference to the Savelsberg Process. H. O. Hofman, R. P. Reynolds and A. E. Wells. Experimental investigation of the effects which variations in the addition of limestone and changes in the volume of blast may exert upon desulphurization, fusibility and losses in lead and silver. 3000 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82510.

Ore Mixing.

The Adjusting of Ores. L. S. Austin. Remarks on schedules of prices and melting charges, sorting and ore manipula-

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tion. 700 w. Eng & Min Jour—Feb. 2, 1907. No. 82093.

Tin.

Cornish Tin Mining. H. E. West. Remarks on the recent revival in tin-mining, reviewing past and present equipment of Cornish mines. Ills. 2000 w. Min & Sci Pr—Feb. 9, 1907. No. 82443.

Zinc.

Dodd City, Ark., Zinc Fields. Illustrated description of this section which promises to become an important producer of lead and zinc. 1200 w. Min Wld—Feb. 23, 1907. No. 82565.

Sheet Ground Mining in the Webb City District. Otto Ruhl. Gives information regarding the profitable mining of low-grade zinc ores, and the development of the "sheet-ground" territory. Ills. 1500 w. Min Rept—Feb. 7, 1907. No. 82204.

Zinc Alloys.

Alloys of Zinc and Iron (Les Alliages de Zinc et de Fer). S. Wologdine. Description of experiments on alloys containing less than 10 per cent. of iron, crystal formation observed, and melting points. Ills. 2400 w. Revue De Métallurgie—Dec., 1906. No. 82310 H.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Car Recording.

A New Method of Car Recording at Local Stations. F. Lincoln Hutchins. Describes a card record system, which has been in use with satisfying results, at the Troy, N. Y., station of the Boston & Maine Railroad, and at other points. 900 w. R R Gaz—Feb. 1, 1907. No. 82077.

Derailment.

Derailment on Curves. H. J. Slifer, with discussion. Considers the principal causes of derailment. 4000 w. Pro Iowa Ry Club—Jan. 11, 1907. No. 82267 C.

Electric Locking.

Electric Locking at Electric Interlocking Plants. W. H. Arkenburgh. Gives diagrams and explanation of two systems. with comments. 800 w. Pro Ry Sig Assn—1906. No. 82484 N.

Freight.

The Profitable Weight and Speed of Freight Trains. M. B. Wild. Editorial letter discussing the economical weight and speed of freight trains. 1000 w. R R Gaz—Feb. 8, 1907. No. 82400.

The Profitable Weight and Speed of Freight Trains. Several letters called forth by the communication by M. B. Wild, discussing the economical weight and speed of freight trains. Also editorial. 6000 w. R R Gaz—Feb. 15, 1907. No. 82401.

Operating Costs.

The Cost of Steam and Electric Locomotive Operation. Gerard B. Werner. Gives an analysis of the reduction in operating costs to be effected by the substitution of electricity for steam on trunk lines. 2000 w. Engineering Magazine—March, 1907. No. 82636 B.

Signalling.

Controlled Manual Block System in Use on Single Track Line of the Illinois Central Railroad. W. W. Salmon. Deals with the reasons that led this railway to adopt the system described, the results obtained, and the cost of its installation and maintenance. 3500 w. Ry Age—Feb. 15, 1907. No. 82427.

Substituting Track Circuits for Detector Bars. W. N. Spangler. A detailed discussion of the working of electric switch locking in signalling, the features to be guarded against, etc. With general discussion. Diagrams. 6000 w. Pro Ry Sig Assn—1906. No. 82481 N.

The Charging of Storage Batteries from Alternating Current Circuits. F. B. Corey. Discusses the source of supply of the charging current for batteries used in signalling. Also discussion. Ills. 4500 w. Pro Ry Sig Assn—1906. No. 82480 N.

The Power Distant Signal. W. A. D. Short. Considers the best means of control for the distant signal. General discussion. 5200 w. Pro Ry Sig Assn—1906. No. 82482 N.

Signalling on the East Bengal State Railways. G. K. Rogers. Illustrates and describes the general arrangement and working of MacKenzie and Holland's Improved Sykes Block. 700 w. Pro Ry Sig Assn—1906. No. 82478 N.

The Optics of the Signal Lens. William Churchill. Aims to give optical data of chief interest to the users of signal lenses, and the optical principles upon which the data depend. Ills. 6500 w. Pro Ry Sig Assn—1906. No. 82486 N.

The Upward Indication of the Semaphore Arm. L. R. Clausen. A discussion of the objections to the downward indication for proceed, and the arguments for the upward indication. Ills. 2000 w. Pro Ry Sig Assn—1906. No. 82483 N.

MOTIVE POWER AND EQUIPMENT.

Buffers.

Dimensions of Buffers for Standard Gage Cars (Dimensions à Adopter pour les Disques Tampons de Choc des Véhicules de Chemins de Fer à Vole Nor-

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male). M. M. Chabal et Beau. Comprehensive discussion of most efficient size of buffer discs to be used under different conditions. Mathematical treatment. Diagrams. 8800 w. Revue Générale des Chemins De Fer—Jan., 1907. No. 82349 G.

Cars.

All-Steel 50-Ton Box Car for the Union Pacific. Photographs, drawings and description. 400 w. R R Gaz—Feb. 22, 1907. No. 82539.

Steel Passenger Cars. Illustrated detailed description of the sample all-steel passenger coach built for the Long Island Railroad. 2000 w. Am Engr & R R Jour—Feb., 1907. No. 82071 C.

Engine Failures.

Engine Failures and Their Report. A paper by W. E. Dunham, introductory to an extended discussion. Ills. 17800 w. Pro W Ry Club—Jan. 15, 1907. No. 82489 C.

Lighting.

Car Lighting. J. R. Cravath and V. R. Lansingh. Discusses the means of securing good illumination and pleasing effect in the electric lighting of cars. Ills. 1200 w. Elec Wld—Feb. 2, 1907. No. 82130.

Locomotives.

Four-Cylinder Compound Locomotives for the Italian State Railroads. Illustrated description of a locomotive at the Milan exposition, which possesses many variations from standard practice. 3000 w. R R Gaz—Feb. 1, 1907. No. 82081.

Locomotives for the Italian Government Railways. Illustrations showing the principal features of American built locomotives of the consolidation type, with single-expansion cylinders, and of the ten-wheel type with balanced compound cylinders, with descriptions. 500 w. Ry Age—Feb. 8, 1907. No. 82202.

Pacific Type Locomotives. Illustrates and describes Pacific type passenger locomotives for the National Railway of Mexico. They include an example of four different cylinder arrangements and of both Walschaert and Stephenson valve gear. 1800 w. Am Engr & R R Jour—Feb., 1907. No. 82075 C.

Mexican Central Oil Burner. A description of this engine, illustrating the firebox. 1000 w. Ry & Loc Engng—Feb., 1907. No. 82126 C.

Four-Cylinder Simple Locomotive. Illustrated description of an Atlantic type locomotive equipped with four simple cylinders. 1200 w. Am Engr & R R Jour—Feb., 1907. No. 82073 C.

Six-Coupled Passenger Express Locomotive; Caledonian Railway. Detailed drawings and description of locomotives used for heavy corridor-train service. 900 w. Engng—Feb. 1, 1907. No. 82256 A.

Four New British Locomotives. Engravings and leading particulars in regard to four engines recently designed and constructed in England. 600 w. Engr, Lond—Jan. 25, 1907. No. 82156 A.

Santa Fe Type Baldwin Locomotive with Superheater, P. S. & N. Ry. Illustrated description of the 30,000th locomotive constructed by the Baldwin Locomotive Works, especially the improved superheater. 700 w. Ry & Engng Rev—Feb. 23, 1907. No. 82559.

Pittsburg Shawmut & Northern 10-Coupled Locomotive. Illustrates and describes an engine using superheated steam economically at a comparatively low pressure. 400 w. Ry Age—Feb. 15, 1907. No. 82428.

Successive Experiments and Improvements on Locomotives of the Pennsylvania Railroad. C. H. Caruthers. An illustrated review of improvements in brakes, smokestacks, and numerous other parts. 6000 w. R R Gaz—Feb. 22, 1907. No. 82537.

Passenger Locomotive with Feed Water Heater (2-4 Gekuppelte Personenzuglokomotive mit Speisewasservowärmern). E. Sauer. A feed water heater located in the smokebox and supplied by a pump. Ills. 5500 w. Zeitschr d Vereines Deutsch Ingenieure—Jan. 5, 1907. No. 82354 D.

Refrigerator Cars.

Refrigerator Cars in France. Illustrates and describes types of cars used by two refrigerator car lines in France, and the shipping of loaded refrigerator cars across the English Channel. 1200 w. Ice & Refrig—Feb., 1907. No. 82123 C.

Resistance.

Train Resistance and Its Calculation by Logical Formulae (Die Widerstände der Eisenbahnzüge und die zu ihrer Berechnung dienenden Formeln). Albert Frank. Comparison of different formulae now in use. 6000 w. Zeitschr d Vereines Deutschr Ingenieure—Jan. 19, 1907. No. 82359 D.

Stokers.

Mechanical Stokers for Locomotives (Mechanische Lokomotir-Bekolungsanlagen). Friedr Zimmermann. Brief review of different devices that have been tried in service. 1700 w. Glaser's Annalen—Jan. 15, 1907. No. 82366 D.

Valves.

Valves and Valve Gearing for Superheated Steam Locomotives. Illustrates and describes two locomotives in service on the Prussian State Railways, fitted with the Lentz system of poppet valves. 1700 w. Mech Engr—Feb. 2, 1907. No. 82237 A.

Wheel Pressures.

Altering Locomotive Wheel Pressures. W. H. Van Druten. Explains a simple

We supply copies of these articles. See page 158.

method by applying a little elementary mathematics. 1000 w. Am Engr & R R Jour—Feb., 1907. No. 82074 C.

NEW PROJECTS.

Africa.

The Southwest African Railway. Dr. Alfred Gradenwitz. An illustrated account of the construction of the Otavi Railway, which is about 360 miles in length. 900 w. Sci Am Sup—Feb. 23, 1907. No. 82577.

Alaska.

Construction of the Alaska Central Railway, with Cost Data. William G. Atwood. An illustrated account of work done on this road since Jan., 1905. Explains some of the difficulties of railroad construction in a cold country. 3500 w. Eng News—Feb. 21, 1907. No. 82529.

China.

Construction of the Shan Tung Railway (Allgemeines und Technisches vom Bau der Schantungbahn). Alex Wenz. Description of location and construction of the roadway and bridges of this important link in the Chinese railway system. Ills. 6100 w. Zeitschr d Vereines Deutscher Ingenieure—Jan. 12, 1907. No. 82356 D.

Tehuantepec.

The Tehuantepec Railway and Terminal Ports. An illustrated description of the railway and the terminal harbors at Salina Cruz and Coatzacoalcos. 4000 w. Engr, Lond—Feb. 1, 1907. No. 82258 A.

PERMANENT WAY AND BUILDINGS.

Four-Track Line.

The New Four-Track Line of the Erie R. R. Through Bergen Hill, Jersey City. Explains the difficulties in the way of railway lines from the west which reach New York City, and describes the new construction work in progress by the Erie R. R. Ills. 1700 w. Eng News—Feb. 21, 1907. No. 82532.

Rails.

Rail Corrugations. R. W. Western. Remarks on the causes after a study of the track of the South London tramways. 2500 w. Tram Ry Wld—Feb. 7, 1907. No. 82591 B.

Rail Corrugation in Great Britain. Gives views of managers and engineers from the principal towns of the country in regard to the cause of corrugation. 9000 w. Tram & Ry Wld—Feb. 7, 1907. No. 82592 B.

Comparison of American and Foreign Rail Specifications, with a Proposed Standard Specification to Cover American Rails Rolled for Export. Discussion of the paper of Albert Ladd Colby. 8000 w. Bul Am Inst of Min Engrs—Jan., 1907. No. 82516 C.

Rail Fastenings.

On the Working Loose of Screws When Used as Rail Fastenings. L. Schlüssel. Analyzes the behavior of the screw under the influence of unsymmetrical loads, and attempts to deduce a method for preventing such loosening. 6500 w. Bul Int Ry Cong—Jan., 1907. No. 82545 E.

Repair Shops.

Railroad Shop Organization. C. J. Morrison. Compares the working of different shops and the effect on the output, showing the importance of organization. 1300 w. Am Engr & R R Jour—Feb., 1907. No. 82072 C.

Roadway.

Pennsylvania Standard Roadway. Brief illustrated description of the standard adopted, and which is being constructed on the main line. 800 w. Ry Age—Feb. 1, 1907. No. 82076.

Station.

Proposed Union Station, Toronto, Canada. Illustrated description of a proposed passenger station building, including baggage buildings and service plant. 1000 w. Ry Age—Feb. 15, 1907. No. 82429.

Tracks.

A Design for Railway Track, Based Upon a Study of the Stresses Existing in Track Superstructure. O. E. Selby. Abstract of a paper in Bul. 30 of the Am. Ry. Engng & Main. of Way Assn. Discusses the design of a track structure that will overcome the defects of the present track. Ills. 2000 w. Eng News—Feb. 14, 1907. No. 82294.

Trestle.

Niagara Canyon Trestle. Illustrated description of a wooden trestle in British Columbia, which carries the Esquimalt and Nanaimo Railway. It is 585 ft. long and the height is 120 ft. 700 w. Ry & Loc Engng—Feb., 1907. No. 82124 C.

TRAFFIC.

Car Shortage.

Clearinghouse Idea in Car Service. Editorial discussing the car shortage trouble and the proposed remedy. 1600 w. Ry & Loc Engng—Feb., 1907. No. 82127 C.

I. Is There a Car Famine? P. B. Vermillion. II. Causes and Remedy for Car Shortage. Ashley J. Elliott. Two papers on the causes of car shortage and the handling of equipment, the remedies, etc. General discussion. 7500 w. Pro Iowa Ry Club—Jan. 11, 1907. No. 82268 C.

The Car Shortage Problem. Extracts from the Interstate Commerce Commissioners' report on the causes and remedies. 2200 w. Ir Age—Feb. 21, 1907. No. 82520.

We supply copies of these articles. See page 158.

Coal Traffic.

First Report of the Interstate Commerce Commission on the Coal Traffic. A review of this report which deals with bituminous coal carried east of the Ohio River, and bounded on the south by the Norfolk & Western R. R., and on the north by Canada. 4000 w. R R Gaz—Feb. 1, 1907. No. 82078.

Handling the Coal Output in Southern Illinois. E. Wallace. An illustrated account of a coal-traffic railway also operated as an interurban trolley line. 500 w. Eng & Min Jour—Feb. 23, 1907. No. 82571.

Freight Traffic.

Watching Freight Traffic by Daily Returns. Describes methods in use on one important British railway and one important American railway, comparing the use made of actual working statistics. Also editorial. 5500 w. R R Gaz—Feb. 1, 1907. No. 82079.

Problems.

Some Railroad Problems. J. B. Thayer. From an address before the Traffic Club of New York. Discusses rebates, rates, passes, present and proposed legislation, etc. 3500 w. Ry & Engng Rev—Feb. 23, 1907. No. 82560.

Report.

Final Report of the Pennsylvania Railroad Special Investigating Committee. Abstract of the report of a committee appointed to investigate charges brought against officers and employees. 4500 w. R R Gaz—Feb. 22, 1907. Serial. 1st part. No. 82538.

MISCELLANY.

Alaska.

The Territory of the Alaska Central Railroad. A. S. Atkinson. Remarks on the development of railroads in Alaska, especially the route of the Alaska Central, and the difficulties, and the rich mineral country through which it passes. 2000 w. R R Gaz—Feb. 15, 1907. No. 82403.

Atmospheric System.

Atmospheric Railroad Traction. W. B. Poley. An illustrated description of this system, and an account of the trials made of it from 1840 to 1860. 1500 w. R R Gaz—Feb. 1, 1907. No. 82080.

Legislation.

Railroad Legislation. George F. Baer. Letter to the Pennsylvania Legislature, giving a statement of the present conditions of railroad transportation. 2800 w. R R Gaz—Feb. 15, 1907. No. 82402.

STREET AND ELECTRIC RAILWAYS

Brake.

The Freund Tramway Brake. Illustrated description of this system which seems to have many practical advantages. 1800 w. Engng—Feb. 15, 1907. No. 82609 A.

Brooklyn Elevated.

The Elevated Shops and Terminals of the Brooklyn Rapid Transit Company—Organization and General Layout at East New York. An illustrated article dealing with the elevated railway shop, terminal construction and operating practices of this company as developed within the last two years. 3000 w. St Ry Jour—Feb. 2, 1907. Serial. 1st part. No. 82116.

Cars.

New Motor Cars for the Metropolitan West Side Railway. Illustrated description of new cars for this Chicago line, which are well adapted to its service and traffic conditions. 1200 w. Elec Ry Rev—Feb. 9, 1907. No. 82217.

Car Houses.

New Car Houses in Baltimore. Illustrated description of the eight car houses, in which special attention has been given to fire protection. 3500 w. St Ry Jour—Feb. 2, 1907. No. 82117.

Car Speeds.

Notes on Speed Time Curves. Tracy W. Simpson. An explanation of a method of plotting speed time curves, and a study of the usefulness of such curves for determining important questions. 3500 w. St Ry Jour—Feb. 9, 1907. No. 82216.

Conduit Systems.

Electric Conduit Street Railroads. C. H. Stut. Discusses the requirements of a good conduit system, especially in reference to the conditions at San Francisco. 1700 w. Cal Jour of Tech—Jan., 1907. No. 82052.

Distribution System.

Feeder and Return Systems. Henry Docker Jackson. Considers rail bonds, cost of distribution systems, and related matters. 1500 w. Elec Ry Rev—Feb. 9, 1907. No. 82218.

Drop.

Drop in Volts. E. Goolding. Explains a method of finding the drop of volts in track, third rail, or trolley wire of any size or length. 1100 w. Tram & Ry Wld—Feb. 7, 1907. No. 82590 B.

Electric Locomotives.

The New Electric Locomotive for the Vienna, Austria, City Lines. C. L. Durand. Illustrates and describes the new electric locomotives which will replace the steam locomotives now in use. 3000 w. Elec Rev, N Y—Feb. 2, 1907. No. 82103.

We supply copies of these articles. See page 158.

Illumination.

Car Lighting. R. C. Taylor. Read before the Cent. Elec. Ry. Assn. Considers the requirements of interurban cars carrying passengers for a long distance; the headlight and also the interior lighting. 2200 w. St Ry Jour—Feb. 2, 1907. No. 82118.

Italy.

Milan-Galarate Electric Railway. Brief illustrated description of the equipment of a railway which has been using continuous-current for the motors with great success. 1000 w. Tram & Ry Wld—Feb. 7, 1907. No. 82588 B.

Electric Traction on Italian Railways. A review of the situation in Italy and the effort to substitute electric traction for all steam railways. 4000 w. Engr, Lond—Feb. 15, 1907. No. 82612 A.

Local Lines.

Electric Traction for Local Lines (La Traction Electrique sur les Lignes de Chemins de Fer D'Intérêt Local). Eric Gérard. Discussion of different systems applicable to railways having strictly local traffic. 3800 w. Serial. 2 parts. L'Electricien—Jan. 12 and 19, 1907. No. 82346 D.

New York.

Transit Facilities in New York. The first of a series of articles describing the nature and progress of transit work in New York City, and the part of the New York Rapid Transit Commission. 3300 w. Engr, Lond—Feb. 1, 1907. Serial. 1st part. No. 82259 A.

Paving.

Paving Between Street Railway Tracks and Rails. B. J. T. Jeup. Read at meeting of the Indiana Engng. Soc. Discusses the types of rails now used, giving arguments for and against them, and discusses the best pavement for city streets. Ills. 1700 w. St Ry Jour—Feb. 9, 1907. No. 82215.

Philadelphia.

Recent Progress in Heavy Electric Railway Work at Philadelphia. Illustrates and describes the work thus far completed in connection with the subway and elevated service. 3500 w. St Ry Jour—Feb. 16, 1907. No. 82437.

Power Stations.

Electric Generating Station of the Paxtang Electric Company of Harrisburg, Pa. Illustrated detailed description of the building and equipment, the transmission lines, sub-station, etc. 4000 w. Elec Wld—Feb. 16, 1907. No. 82430.

New Power Station of the Illinois Traction System at Peoria, Ill. C. S. Johnson. Illustrated detailed description of the building, its arrangement and equipment. 2500 w. Elec Ry Rev—Feb. 23, 1907. No. 82552.

Rapid Transit.

Urban and Suburban Traffic. Lynden Macassey. Read before the Economic Soc. of the British Assn. Discusses the distribution of population by facilities of rapid transit, as a relief for concentrated districts. 4800 w. Engng—Feb. 8, 1907. No. 82469 A.

Side Slot.

Side Slot Point for Conduit Tramways. Illustrated detailed description of the point, invented by A. N. Connett, for conduit tramways in cases where the slot forms the groove of one rail instead of being midway between the rails. 900 w. Tram & Ry Wld—Feb. 7, 1907. No. 82589 B.

Signaling.

Alternating Current Track Circuits in the New York Subway. J. W. Waldron. Illustrated detailed description of the system installed with explanation of the reasons for adopting it. 1200 w. Pro Ry Sig Assn—1906. No. 82485 N.

Spokane.

The Spokane & Inland Empire System. Map and illustrated description of an electric line approaching in character the usual steam roads. Also brief outline of the history of the line. 2000 w. Ry & Engng Rev—Feb. 9, 1907. No. 82203.

Substation.

New Substation of the International Railway Company, Buffalo, N. Y. Illustrated description of the Seneca Street substation just completed. 1800 w. Elec Ry Rev—Feb. 16, 1907. No. 82436.

Tracks.

Track Construction on Interurban Tramways. M. Dubs. The author reports on the results of inquiries made into the various methods in use for track construction on tramways. A large number of systems are described and discussed. Ills. 3000 w. Elect'n, Lond—Jan. 25, 1907. Serial. 1st part. No. 82144 A.

Traction.

Development of Electric Traction (Le Développement de la Traction Electrique). DeValbreuze. Account of the development and present state of heavy electric railroading in Europe and the U. S. Ills. 19000 w. Bul de la Soc Int des Electriciens—Jan., 1907. No. 82344 F.

Wires.

Some Notes on the Breaking of Trolley Wires. P. S. Sheardown. Read before the Dublin Sec. of the Inst. of Elec. Engrs. Discusses the causes, showing that the size of wire is not of importance. Proposes the anchoring of the trolley wire at each suspension, and suggests a simple means of doing this. 2000 w. Elect'n, Lond—Jan. 11, 1907. No. 81739 A.

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EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cents per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

American Architect. *w*. New York.
Am. Engineer and R. R. Journal. *m*. New York.
American Jl. of Science. *m*. New Haven, U. S. A.
American Machinist. *w*. New York.
Annales des Ponts et Chaussées. *m*. Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w*. Rome.
Architect. *w*. London.
Architectural Record. *m*. New York.
Architectural Review. *s-q*. Boston.
Architect's and Builder's Magazine. *m*. New York.
Australian Mining Standard. *w*. Melbourne.
Autocar. *w*. Coventry, England.
Automobile. *w*. New York.
Automotor Journal. *w*. London.
Beton und Eisen. *qr*. Vienna.
Boiler Maker. *m*. New York.
Brass World. *m*. Bridgeport, Conn.
Brit. Columbia Mining Rec. *m*. Victoria, B. C.
Builder. *w*. London.
Bull. Am. Iron and Steel Asso. *w*. Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m*. Paris.
Bulletin of Dept. of Labor. *b-m*. Washington.
Bull. Soc. Int. d'Electriciens. *m*. Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m*. Lawrence.
Bull. Int. Railway Congress. *m*. Brussels.
California Jour. of Tech. *m*. Berkeley, Cal.
Canadian Architect. *m*. Toronto.
Canadian Electrical News. *m*. Toronto.
Canadian Engineer. *m*. Toronto and Montreal.
Canadian Mining Review. *m*. Montreal.
Cassier's Magazine. *m*. New York and London.
Cement. *b-m*. New York.
Cement Age. *m*. New York.
Central Station. *m*. New York.
Chem. Met. Soc. of S. Africa. *m*. Johannesburg.
Colliery Guardian. *w*. London.
Compressed Air. *m*. New York.
Comptes Rendus de l'Acad. des Sciences. *w*. Paris.
Consular Reports. *m*. Washington.
Deutsche Bauzeitung. *b-w*. Berlin.
Domestic Engineering. *w*. Chicago.

Economic Geology. *m.* So. Bethlehem, Pa.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Industrial World. *w.* Pittsburg.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Motor Wagon. *w.* Cleveland, U. S. A.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista d Obras. Pub. *w.* Madrid.
Review of Reviews. *m.* London & New York.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Technograph. *yr.* Urbana, Ill.
Technology Quarterly. *qr.* Boston, U. S. A.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

BOOKS RECEIVED.

The Analysis and Softening of Boiler Feed-Water. By Edmund Wehrenfennig and Fritz Wehrenfennig. Translated from the German by D. W. Patterson. Size, 9 by 6 in.; pp. xiv, 290. Figures, 171. Price, $4. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

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